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11TH ANNUAL CORNEA REPORT

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**References:** 1. Fogt J, Patton K. Long day wear experience with water surface daily disposable contact lenses. *Clin Optim.* 2022(14):93-99. 2. Perez-Gomez I, Giles T. European survey of contact lens wearers and eye care professionals on satisfaction with a new water gradient daily disposable contact lens. *Clin Optim.* 2014;6:17-23. 3. In a clinical study wherein patients (n=66) used CLEAR CARE® solution for nightly cleaning, disinfecting, and storing; Alcon data on file, 2021.

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REVIEW OF OPTOMETRY • VOL. 161, NO. 4 • APRIL 15, 2024 • Staff Recruitment and Development • Diagnostic



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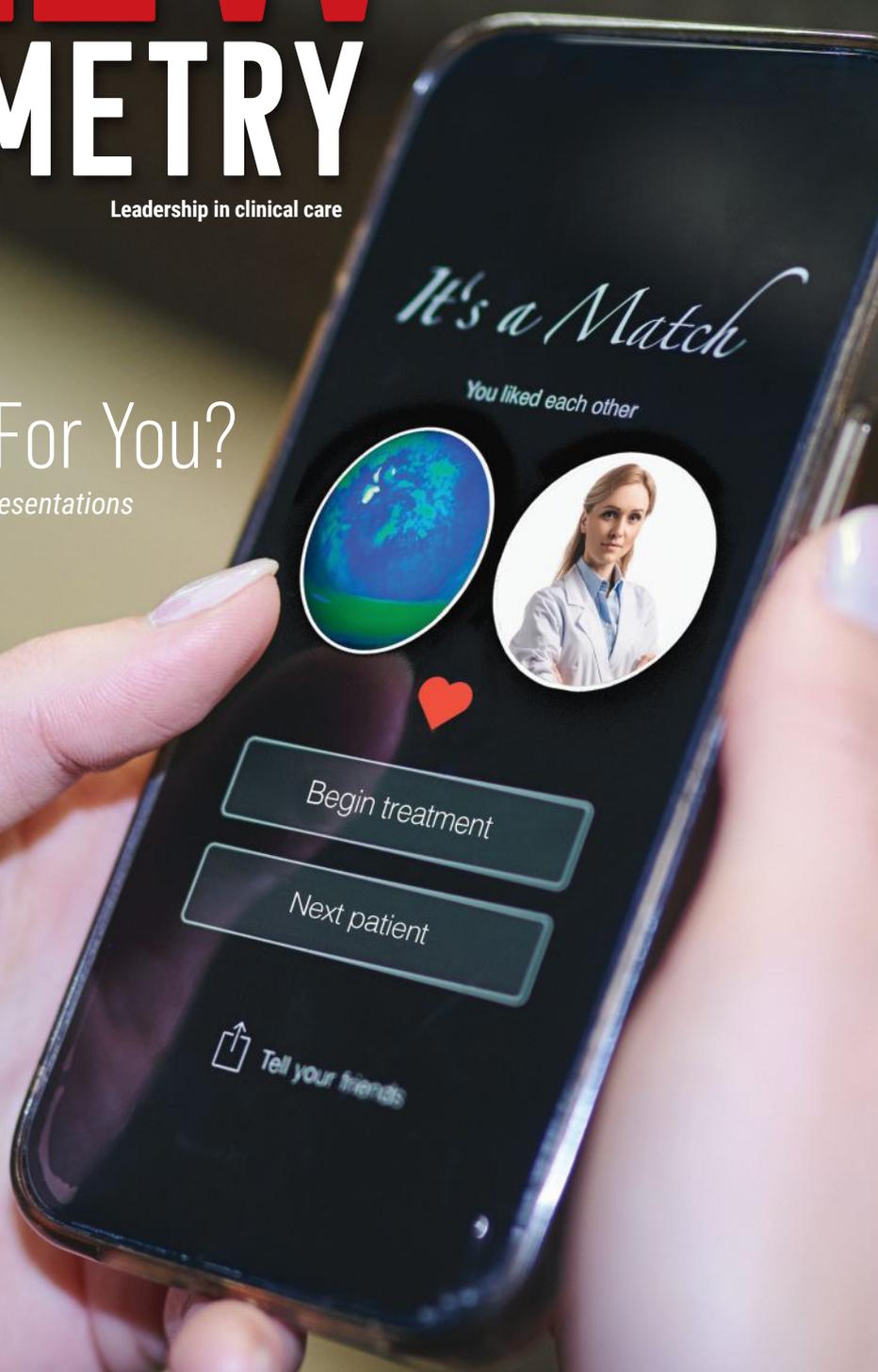
## CORNEAL CASES: Which are Right For You?

*Here's how to evaluate a wide array of presentations and decide whether to accept or send to another provider. PAGE 52*

**Keratoconus**, PAGE 32

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1. JJV Data on File 2022. TearStable™ Technology Definition.

2. JJV Data on File. CSM Subjective Responses ACUVUE® OASYS MAX 1-Day Contact Lenses - Retrospective Meta-analysis.

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## Atropine 0.05% Effective For Myopia Control at Five Years

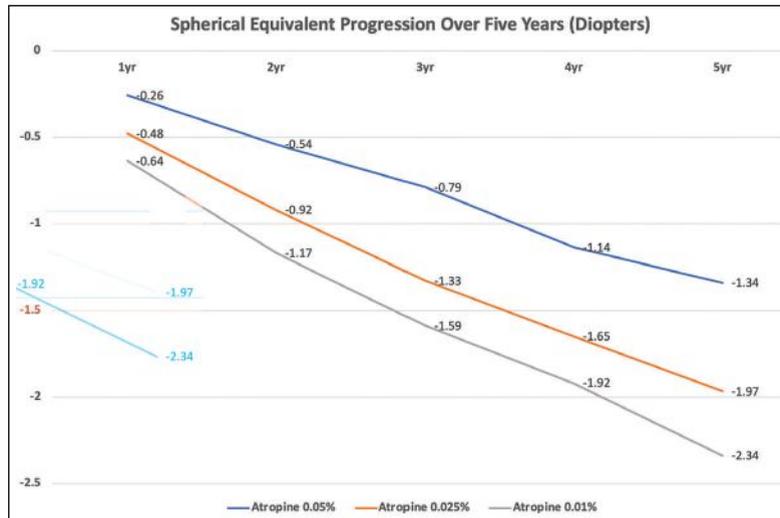
*A follow-up of the LAMP Study found that the intervention even performed equally well in patients who had to restart treatment after a year of recession.*

Using low-concentration atropine eye drops to help slow the progression of childhood myopia is a trending topic in research, as questions remain regarding optimal dosing and outcomes. One previous high-ranking study on this emerging therapy, called the Low Concentration Atropine for Myopia Progression (LAMP) Study, found that 0.05% atropine was the most effective concentration over three years when comparing 0.05%,

0.025% and 0.01% atropine. Additionally, it found that patients who received three years of atropine treatment fared better than those who only received two years.

To further evaluate the long-term efficacy of 0.05% atropine treatment out to five years, researchers recently returned to the LAMP Study dataset to perform a follow-up study on 269 children aged four to 12. At five years, the data showed that continued 0.05% atropine treatment demonstrated good efficacy for myopia control.

Many of the study participants didn't receive treatment in year three but resumed it in year four; this is because during the third year of the LAMP Study, children in the 0.05%, 0.025% and 0.01% atropine groups were



**The original LAMP Study found that atropine 0.05% was more effective at slowing myopia progression than 0.025% or 0.01% formulations. Now, a follow-up study on some of the same participants shows atropine 0.05% is effective at five years, with similar outcomes among children who had initially used other concentrations.**

randomized to continued treatment and treatment cessation. In follow-up years four and five, all participants were switched to 0.05%, “while all treatment cessation subgroups followed a PRN retreatment protocol to resume 0.05% atropine for children with myopic progressions of 0.5D or more over one year,” the researchers explained in their paper on the study for *Ophthalmology*.

The results showed that over the five years, the cumulative mean spherical equivalent (SE) progressions were  $-1.34 \pm 1.40D$  for the initial 0.05% atropine group,  $-1.97 \pm 1.03D$  for the initial 0.025% atropine group and  $-2.34 \pm 1.71D$  for the initial 0.01% atropine group. Axial length elongation over the five years displayed a similar trend among groups.

Among the PRN treatment group, 87.9% of children needed retreatment. Between years three and five, the SE progression for this group was  $-1.00 \pm 0.74D$ , and axial length elongation was  $0.49 \pm 0.32mm$ . For the continued treatment group during those three years, SE progression was  $-0.97D \pm 0.82D$ , and axial length elongation was  $0.49 \pm 0.32mm$ .

Most children needed to restart treatment after atropine cessation at year three, and notably, for those who did, 0.05% atropine achieved similar efficacy as continued treatment.

The researchers summarized their findings into three points:

1. Continued 0.05% atropine treatment was effective in myopia control with good tolerance over five years.
2. Retreatment should be considered for those who have experienced myopia progression after stopping treatment.
3. For children at high risk of myopia progression, continued treatment with 0.05% atropine during the first five years is suggested. ◀

Zhang XJ, Zhang Y, Yip BHK, et al. Five-year clinical trial of low-concentration atropine for myopia progression (LAMP) study: phase 4 report. *Ophthalmology*. March 15, 2024. [Epub ahead of print].

# Popular Drug for Type 2 Diabetes May Lower Glaucoma Risk

Recent studies have demonstrated that a medication commonly prescribed for type 2 diabetes and obesity, glucagon-like peptide-1 receptor agonists (GLP-1RA), plays a role in facilitating retinal neuroprotection, which, in turn, may prevent glaucoma development and progression. Researchers in Denmark performed a nested case-control study to compare glaucoma risk in individuals with type 2 diabetes treated with GLP-1RA—a second-line antihyperglycemic medication—vs. those receiving alternative treatments. Their data concluded that GLP-1RA exposure was associated with a lower glaucoma risk compared to other antihyperglycemic meds, especially in patients receiving treatment for longer than three years.

Of 264,708 individuals in the Danish database, 1,737 incident glaucoma cases were identified and matched to 8,685 controls without glaucoma, all of whom were above 21 years old, had no history

of glaucoma and were treated with metformin and a second-line antihyperglycemic drug formulation (a GLP-1RA).

Compared to the control group, which received treatments other than GLP-1RA, those treated with GLP-1RA had a lower risk of incident glaucoma (HR: 0.81), which was reduced 29% further with prolonged treatment extending beyond three years (HR: 0.71).

In their *Ophthalmology* paper, the authors noted that their work accomplished two things. “First,” they wrote, “the use of GLP-1RA was associated with a 19% decrease in risk of glaucoma. Second, increased exposure to GLP-1RA, especially over extended durations, accentuated this protective association with a duration-response pattern. Notably, with a significant 29% risk reduction when looking at three or more years exposure to GLP-1RA.”



Photo: Business Insider

**GLP-1RAs may become a potential adjunctive therapy for glaucoma. Examples include Exenatide (Byetta), Semaglutide (Ozempic), Liraglutide (Victoza, Saxenda) and Lixisenatide (Adlyxin).**

These findings support the possibility of GLP-1RA being an adjunctive therapy in glaucoma management, the authors argue. They advised, “The lower risk of developing glaucoma among individuals with type 2 diabetes on GLP-1RA warrants further investigation to establish if there is an effect beyond improved glycemic control.”

Niaz S, Gnesin F, Thein A-S, et al. Association between glucagon-like peptide-1 receptor agonists and the risk of glaucoma in individuals with type 2 diabetes. *Ophthalmology*. March 13, 2024. [Epub ahead of print].

# Investigational Subretinal Implant May Restore Vision Loss from GA

One of the major disabilities for patients with advanced AMD involving geographic atrophy (GA) is the gradual decline and then permanent loss of reading ability within the central field. Though photoreceptors are lost within atrophic areas, the inner retinal neurons largely survive. A prosthetic device called Prima (Pixium Vision) is a wireless subretinal receiver in

which photovoltaic pixels directly convert projected light into patterns of electric current to reintroduce visual information by electrical stimulation of second-order neurons—the bipolar cells.

While Prima is not yet available, a study in *Ophthalmology Science* assessed its efficacy and safety in five patients. Up to four years after implantation, the subretinal chip (activated by a pair of light-sensing glasses) enabled subjects to read at least four more lines on the vision chart compared with baseline. “Prosthetic central vision provided by photovoltaic neurostimulation enabled patients to reliably recognize letters and sequences of letters, and with zoom it improved VA of up to eight ETDRS lines,” the authors wrote.

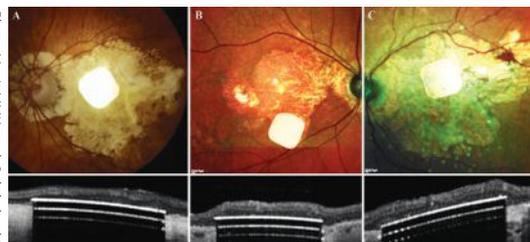
The current version of this implant is a 2mm wide and 30µm thick chip. Images captured by the camera using

augmented reality glasses are processed and projected onto the implant using near-infrared light. Photovoltaic pixels convert this into electric current flowing through the retina between the active and return electrodes, which stimulates the nearby inner retinal neurons. Their responses then pass through the retinal neural network to ganglion cells, harnessing residual signal processing.

Without zoom, VA corresponded to mean Snellen 20/500, ranging from 20/438 to 20/565. Using zoom at 48 months, VA in subjects improved by 32 ETDRS letters vs. baseline.

“Unlike the current pharmacological treatments for GA, which aim to slow down the growth of atrophic lesions without any functional improvement in VA, our results demonstrate restoration of central vision in the former scotoma,” the researchers noted.

Muqit M, Mer YL, de Koo LO et al. Prosthetic visual acuity with the PRIMA subretinal microchip in patients with atrophic age-related macular degeneration at four years follow-up. *Ophthalmol Sci*. March 7, 2024. [Epub ahead of print].

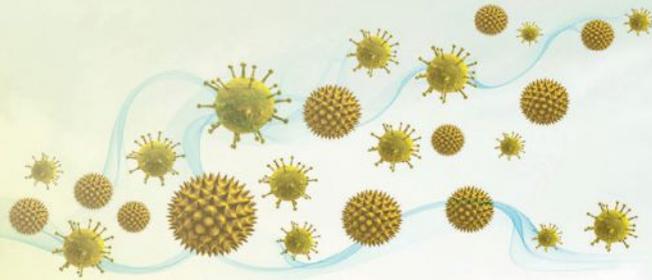


**Subretinal implantation of Prima in subjects with GA suffering from profound vision loss due to AMD is feasible and well tolerated, according to this study. These photos and OCT scans show placement in the three successful subjects. (The two white lines below the implant surface are OCT artifacts due to strong light reflection from the implant surface.)**

Photo: Meqri MMK, et al. *Ophthalmol Sci*. March 7, 2024.

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SCOPE

## Investigative GA Drug Fares Poorly in Phase II Trial

*After 24 months of treatment with oral minocycline, participants showed no significant decrease in lesion enlargement rate. Mild and moderate AEs were also common.*

**M**ore than 15 treatments are currently under investigation for geographic atrophy (GA). Though last year saw the first two drug approvals for GA, these therapies have relatively modest anatomic efficacy, require intravitreal injection and increase the risk of neovascular age-related macular degeneration (AMD), signaling the need for more desirable, less invasive treatment approaches.

One candidate for GA undergoing clinical trials is oral minocycline, a microglial inhibitor. This investigative drug recently wrapped up its Phase II prospective, single-arm, 45-month nonrandomized controlled trial, the outcomes of which were detailed in a recent *JAMA Ophthalmology* study. The findings showed that oral minocycline 100mg is likely not associated with a slower rate of enlargement of GA in AMD.

Thirty-seven patients with a mean age of 74.3 years were enrolled in the trial. The study's primary outcome measure, assessed at week 33, was the difference in the rate of change of square root GA area on fundus autofluorescence between the 24-month treatment phase and a nine-month run-in phase, which took place before treatment was initiated.

After comparing data from the run-in phase vs. the treatment phase, researchers concluded that minocycline did not significantly decrease

GA enlargement over the 24 months of the trial. The mean square root GA enlargement rate among study eyes was 0.31mm per year during the run-in phase and 0.28mm per year during the treatment phase, for a minuscule difference of -0.03mm per year between the two phases.

The mean difference in rate of change between the two phases was also not significantly different; for visual acuity, the difference was 0.2 letter score per month, and for subfoveal retinal thickness, the difference was 0.7 $\mu$ m per month.

Regarding treatment-emergent adverse events, a hefty total of 129 occurred among the 32 participants, though importantly, none were considered severe. Forty-nine adverse events (38%) were related to minocycline (none were ocular), including elevated thyrotropin level (15 cases) and skin hyperpigmentation/dyscoloration (eight cases).

To sum up all these data points, the researchers wrote in their paper that oral minocycline "was not associated with a definitive decrease in rates of decline in BCVA, low luminance visual acuity or subfoveal retinal thickness," and that, "no consistent signal of a clinically meaningful treatment effect was apparent, either for structural or visual acuity endpoints."

The study authors attempted to theorize reasons for the treatment's lack

of effect. The most likely explanation, they noted, is that "minocycline has no substantial association with slowing GA enlargement. It is possible that minocycline did not inhibit microglia consistently at the site of disease progression, potentially related to dose, bioavailability or pharmacokinetics," they wrote. It's also possible that a type II error occurred, given the small number of participants in the trial, though the authors argued in their paper that "this scenario seems unlikely; a sample size of 17 participants was calculated as necessary for 90% power."

In conclusion, the Phase II trial for oral minocycline as a treatment for GA in AMD did not observe a significant clinical treatment effect, at least not at the tested dose of 100mg. While the drug was relatively tolerable, it also led to a high number of mild or moderate systemic adverse events. "However," the authors wrote, "given the potential disadvantages of existing therapeutic approaches, additional strategies remain desirable. It may be necessary to elucidate more clearly the pathogenetic mechanisms underlying GA incidence and progression to develop therapies that target the underlying disease processes." ◀

Keenan TDL, Bailey C, Abraham M, et al. Phase II trial evaluating minocycline for geographic atrophy in age-related macular degeneration: a nonrandomized controlled trial. *JAMA Ophthalmol.* March 14, 2024. [Epub ahead of print].

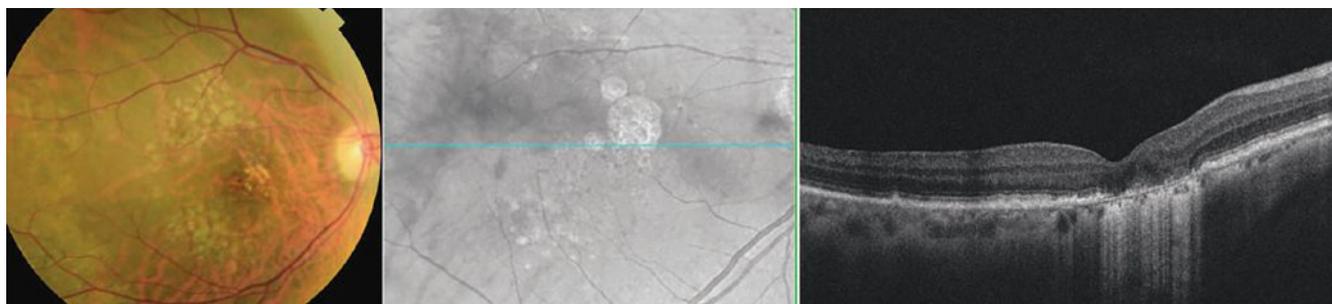


Photo: Wendy Harrison, OD, PhD

**At a dose of 100mg, oral minocycline appeared to have no clinically meaningful treatment effect on GA in AMD among 37 Phase II trial participants.**



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# Endogenous Endophthalmitis Rates Higher in the South

While regional variation exists in the infectious microbes that cause the condition, methicillin-sensitive *Staphylococcus aureus* was the most common.

Among the most visually threatening conditions in eye care, endophthalmitis typically occurs when organisms from the ocular flora of the anterior eye structures gain access to the intraocular space, chiefly during cataract surgery. A rarer form of the condition arises when a blood-borne pathogen reaches the eye in the presence of systemic infection; this is termed *endogenous endophthalmitis* to distinguish it from external (or *exogenous*) sources of infection. It has the potential for rapid progression and severe visual impairment.

Understanding regional variation in endogenous endophthalmitis is not only important for accurate diagnosis and appropriate management but also has implications for visual outcomes. Researchers at Rutgers New Jersey Medical School explored the interplay between regional variation and microbial infection in endogenous endophthalmitis and its possible impact on surgical intervention with pars plana vitrectomy (PPV) or mortality. Their findings revealed significant regional differences in patient demographics, comorbidities, microbial etiology, use of PPV and mortality rate throughout the US.

This retrospective analysis, which was published recently in *Ophthalmology Retina*, used the National Inpatient Sample database. Endogenous endophthalmitis cases were stratified

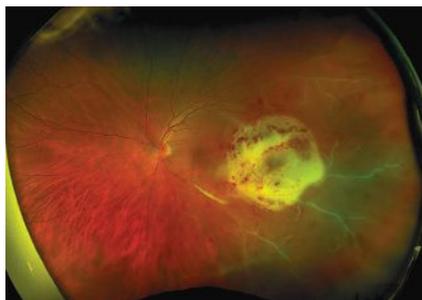


Photo: Rami Abounoured, OD

**Higher rates of vitrectomies were seen in the South and Midwest regions compared to the Northeast and West for patients presenting with endophthalmitis.**

regionally into Northeast, South, West and Midwest cohorts.

A total of 10,912 patients with infectious endogenous endophthalmitis were identified, with 18.9% of cases in the Northeast, 19.7% of cases in the Midwest, 37.9% of cases in the South and 23.6% cases in the West. Analysis indicated significant regional variation in patient demographics, causative microbes, comorbidity patterns, mortality rates and surgical interventions. The most common pathogens across all regions were methicillin-sensitive *Staphylococcus aureus* (MSSA), *Streptococcus*, *Candida* and methicillin-resistant *Staphylococcus aureus* (MRSA). While MSSA was the predominant pathogen in all regions, the proportions varied significantly. *Streptococcus* was the second most common pathogen in the Northeast and Midwest, while MRSA held

this position in the South and *Candida* in the West.

The Northeast had the highest proportion of in-hospital mortality, most likely as a direct result of systemic complications caused by virulent organisms. “This region also had a much higher proportion of the 80+ age group, which may have contributed to increased frailty and possibly a more complicated hospital course,” the authors noted in their paper. “This study showed an in-hospital mortality rate of 8% to 15%, depending upon region, and is generally in agreement with other studies from the US and other developed nations.”

The South and Midwest regions had higher rates of PPV for endogenous endophthalmitis, which also might suggest a regional variation in practice pattern.

“Understanding and addressing regional variations may expedite optimal diagnosis, management and outcome of endogenous endophthalmitis,” the study concluded. “Tailored treatment strategies, informed by regional microbial patterns, may lead to improved empirical therapy and better visual outcomes. Efforts should be directed towards reducing regional outcome disparities through improved access to specialized ophthalmic care, early diagnosis and prompt initiation of appropriate treatment.” ◀

Aftab OM, Dupaguntla A, Khan H, et al. Regional variation of infectious agents causing inpatient endogenous endophthalmitis in the US: a national analysis. *Ophthalmology Retina*. March 14, 2024. [Epub ahead of print].

## IN BRIEF

**Study Identifies Risk Factors for Strabismus in Adults Born Preterm.** A new study assessed the prevalence and associated factors for strabismus, as well as nystagmus, in preterm and full-term infants in adulthood using data from the Gutenberg Prematurity Eye Study. Among its conclusions was that **low gestational age and refractive errors are independent risk factors for strabismus, with**

**esotropia being the most common form.**

In total, 892 eyes of 450 individuals were included from the Gutenberg Prematurity Eye Study, a retrospective cohort study including preterm and full-term adults between 18 and 52 years old. **The researchers linked several factors to the presence of strabismus in the multivariable regression model, including gestational age (odds ratio: 0.90), anisometropia  $\geq 1.5D$  (OR: 3.87), hypermetropia**

**$\geq 2D$  (OR: 9.89) and astigmatism  $\geq 1.5D$  (OR: 2.73).** Other significant observations from the analysis included that esotropia was more common than exotropia and hypermetropia/hypometropia; most patients developed strabismus within the first 10 years of life; and perinatal adverse events were the strongest predictor associated with nystagmus (OR: 15.8).

“The earlier participants were born, the higher the prevalence of strabismus and nystagmus in

adulthood,” the researchers noted in their paper on the findings.

Since the data also showed that strabismus often occurs during early childhood in individuals who were born preterm, **there may be a need “to evaluate whether screening in this high-risk population for amblyopia should be recommended,”** the authors suggested.

Fieß A, Dautzenberg K, Gißler S, et al. Prevalence of strabismus and risk factors in adults born preterm with and without retinopathy of prematurity: results from the Gutenberg Prematurity Eye study. *Br J Ophthalmol*. March 19, 2024. [Epub ahead of print].

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## Study: Half of MS Patients Will Develop Ocular Involvement

**M**ultiple sclerosis (MS) is the most common chronic disabling central nervous system disorder in young adults. With an estimated prevalence of two in 1,000 people globally and an increased prevalence in Western countries, MS affects no shortage of individuals.

A key manifestation of MS is ocular involvement that can result in significant disability and visual impairment. As such, researchers wanted to investigate the population-based frequency and severity of MS-related ocular diseases. Their retrospective study for *Journal of Neuro-Ophthalmology* included 116 MS patients examined between 1998 and 2011 in Olmsted County, Minnesota. MS diagnosis was confirmed with neuroimaging, cerebrospinal fluid studies and serum studies.

Totaling 116 patients, 66% of these were women and median onset age of MS was 36 years. Of this, 53% experienced MS-related neuro-ophthalmic manifestations during their disease course, with 28% showing visual symptoms as their presenting MS symptom, most commonly optic neuritis (22%). This was also the leading MS-related



Photo: Joseph Sowka, OD

**Optic neuritis was the most common ocular manifestation of MS in the study, followed by internuclear ophthalmoplegia and nystagmus.**

ocular condition to develop over time (37%), followed by internuclear ophthalmoplegia (16%) and nystagmus (13%). Optic neuritis was unilateral in 93% of cases and 16% had visual acuity of 20/200 or worse at the lowest point; however, 95% of cases resolved to visual acuity of 20/40 or better.

In their discussion, the study authors relay that their findings agree with previous studies documenting a primarily young female base of MS patients. They then elaborate on prior research on optic neuritis prevalence and its conversion to MS, which has been estimated to be 20% to 50% after 20 years. However, previous

research detailing the frequency of optic neuritis as a presenting MS symptom and its frequency during disease course is limited, with reported rates of 13% to 31% and 27% to 66%, respectively.

Finally, the authors add that their findings of typical MS-related optic neuritis being unilateral, retrobulbar and generally resulting in good visual outcomes are also reflective of prior studies.

With over one in two MS patients affected ocularly in this cohort, the authors stress, “Our work underscores the importance of collaboration between neurologists and ophthalmologists for the diagnosis and management of MS since several of its ophthalmologic manifestations may require treatment (*e.g.*, prism for diplopia) or can be subtle and missed without a detailed ophthalmic exam.”

They suggest “dedicated ocular exams including orthoptics examination for ocular motor disorders and optic neuropathy testing (color plates, OCT and visual field examinations) are helpful both for making baseline diagnoses and for tracking disease progression.” ◀

Kraker JA, Xu SC, Flanagan EP, et al. Ocular manifestations of multiple sclerosis: a population-based study. *J Neuro-ophthalmol.* March 8, 2024. [Epub ahead of print].

## Greater Ptosis Incidence in DR Patients

**A** recent study in Taiwan found that patients with diabetic retinopathy (DR) also had a greater risk of developing ptosis, demonstrating a need for ODs to screen for this comorbidity in patients with diabetes or DR.

To investigate ptosis risk in DR, researchers performed a large, 13-year retrospective cohort study using follow-up data from 9,494 patients with DR and 37,976 matched controls without DR.

The results revealed that DR patients had a significantly increased risk of developing ptosis (adjusted hazard ratio: 2.76) vs. the control cohort. Further analysis showed that among DR patients, adults and non-smokers had a greater risk for ptosis development. Additionally, DR

patients had an increased risk of ptosis vs. matched controls regardless of whether they had medical comorbidities of lipid metabolism disorders or hypertension.

Because the study population was entirely ethnic Asian Taiwanese, it’s unknown whether these findings will apply to other nationalities. The authors also pointed out in their paper, “Patients of Asian ethnicity have been shown to be more predisposed to diabetic complications than compared to their Caucasian counterparts. How this translates towards actual risk of developing ptosis among DR patients is still unknown.”

Speaking on all of their observations, the study authors wrote in their paper, “This has implications towards the care of



Photo: Paul Azzaman, OD

**Researchers recommend screening patients with diabetes and/or DR for ptosis.**

diabetic patients; complications such as ptosis should be properly screened for when encountering such patients.” They also recommended, “Before ptosis surgery, the possibility of underlying diabetes or DR should be scrutinized and treated properly to avoid undesirable postoperative dissension.” ◀

Lin CJ, Hsu AY, Tien PT, et al. Diabetic retinopathy as a potential risk factor for ptosis: a 13-year nationwide population-based cohort study in Taiwan. *Front Epidemiol.* March 13, 2024. [Epub ahead of print].

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# One Scope Bill Passed; Eight Others in Progress

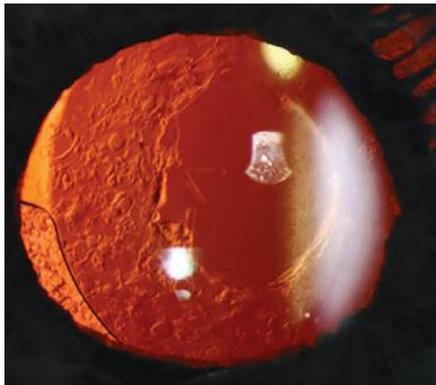
*South Dakota ODs earned the right to pursue lasers, injections and IPL in early March. Four other states have lost their legislative battles, but several more remain in the game.*

In the first two months of 2024, at least a dozen scope expansion bills were introduced or still active from 2023 in states across the US, 10 of which were pursuing the use of optometric lasers. Since then, one laser bill was successfully passed in South Dakota, which now holds the title of the 12th laser state. Legislation in four other states has unfortunately met its demise since January: California, Kansas, Utah and, most recently, West Virginia. These recent events bring the count of active scope bills down to eight. Optometrists in the District of Columbia are pushing for use of controlled substances, while those in Alabama, Missouri, Nebraska, New Hampshire, New Jersey, Ohio and Vermont are pursuing the use of optometric lasers and other minor surgical procedures.

## South Dakota Wins Lasers

Come July 1, optometrists in South Dakota (SDOS) can begin training to offer several advanced procedures involving the use of lasers and injectable therapies as well as intense pulsed light (IPL) therapy for dry eye. On March 4, Gov. Kristi Noem signed the state's scope expansion bill (HB 1099) into law. This action brings the tally of optometric laser states up to 12, following the recent recognition of Wisconsin's use of such procedures under a broadly worded scope law, plus the previous 10 states with explicit legislation to that effect and now South Dakota's milestone in the same vein.

According to a statement released by the South Dakota Optometric Society, HB 1099 permits optometric performance of SLT for glaucoma and YAG capsulotomy for posterior capsular opacification after cataract surgery. It also allows the following three injectable procedures:



Photos: Nate Lighthizer, OD

**South Dakota's scope win brings the number of optometric laser states up to 12. YAG capsulotomy and SLT are allowed there, plus three injection procedures and IPL.**

- Use of Botox around the eye for a medical purpose only.
- Use of a steroid by injection to treat a chalazion.
- Use of an anesthetic by injection to remove a pedunculated skin tag.

The bill also resolves a dispute over the use of IPL by optometrists in South Dakota. That right was earned last October but the state medical association initiated a lawsuit to prohibit it. "The case was pending at bill introduction and including it in the bill clears up the lawsuit," the release from the society explains.

"Despite all of these procedures being taught in every optometric college in the nation since at least 2015, optometrists are required to complete a three-part 'prove up' process to perform any added procedure," the SDOS statement continues. The "prove up" process included in the bill requires:

- Passage of a national examination on laser procedures and a national examination on injection procedures (graduates prior to July 1, 2024 are grandfathered in).
- Passage of a 32-hour certification course to demonstrate competency on each of the added procedures.
- Hands-on demonstration of the procedures on at least five human

eyes for eyelid procedures and SLT and 10 human eyes for YAG under the direct supervision of an ophthalmologist or authorized optometrist to prove competency in each of the procedures.

"I am so proud of our member doctors for the support they provided in passing this bill," said SDOS President-Elect Ashley Crabtree, OD, in the statement released to the media. "When asked, they responded and met with legislators, texted, called and emailed. Several ODs made the trip to the state Capitol to lobby legislators and testify in committee. Our board also allocated resources to put together a great lobbying team led by our executive director, Deb Mortenson. We also had a robust social media and digital ad campaign to support the effort."

## Bills on the Move

The cover story of our March issue detailed the status of every scope bill in play across the country as of late February. Since then, legislation in several states has continued to advance. Here are some scope updates that have transpired in recent weeks:

**Ohio.** Filed last summer as SB 129, Ohio's scope bill proposes allowing its ODs to perform various advanced pro-

cedures and use lasers for capsulotomy, SLT and LPI. Its progress since has been sluggish, but fortunately it appears things are finally speeding up.

The Ohio Optometric Association reports that a meeting was held before the Senate Health Committee on February 28, during which numerous optometrists, optometry students and other advocates were in attendance to support Senator Jerry Cirino as he provided his sponsor testimony.

**Missouri.** Two identical laser bills are currently in play in Missouri—SB 956 and HB 1963—proposing to modernize optometry’s scope to include all procedures taught in optometry schools today. The House bill remains in the Health Committee, which held a public hearing in February, and SB 956 was heard last month by the Senate Governmental Accountability Committee, though no decisions have been reported at the time of this writing.

**New Jersey.** Yet another state with complementary laser bills in play, New Jersey’s efforts are also seeing some action; on March 14, the Assembly Regulated Professions Committee unanimously released the state’s Assembly bill, A-920, proposing expansion of optometry’s practice scope to include modern surgical and laser procedures. Currently, A-920 is on second read-

ing in the Assembly, and the identical Senate bill, S-354, resides in the Senate Commerce Committee.

“We are continuing to build support for the bill and hope it will receive further action later in the spring,” the New Jersey Society of Optometric Physicians reports.

## Recent Losses

In the last month, the following states have had their scope bills pulled from the 2024 session:

**Utah.** After losing a scope battle last year, ODs and the Utah Optometric Association (UOA) reintroduced laser bill SB 210 in early 2024 that, if passed, would have modernized a 30-year-old practice law. However, the effort was undone weeks later by ophthalmology’s interference. The bill secured a favorable vote in the Health and Human Services Committee in February but died on March 1 when the Senate filed it under “bills not passed.” Weston Barney, UOA president, clarifies that SB 210 never actually faced a vote by the Senate. Instead, “it succumbed to behind-the-scenes politics and favors extended to the Utah Ophthalmology Society,” he says.

“Utah scope bills have always been directed to the Business and Labor committee, and we had initially secured

the sponsorship of that committee chair,” Dr. Barney elaborates. “However, Senate President Stuart Adams, previously believed to be supportive of our cause, aligned himself with the ophthalmology society and redirected our bill to a committee chaired by and stacked with medical physicians who oppose all scope expansion unless it benefits the MD/DO community.

“We ultimately decided that the extensive regulations and demands were too oppressive to gain YAG privileges,” Dr. Barney explains. “We opted to postpone the presentation of SB 210 to the Senate, fearing that some of our previously pledged votes might waver due to the Senate President’s influence.”

The UOA has definite plans to reintroduce the bill in the future, he assures.

**Kansas.** This rural state introduced companion bills SB 490 and HB 2779 in February proposing to include the following advanced procedures in optometry’s practice scope: lesion and foreign body removal, subcutaneous injections, laser capsulotomy, SLT and LPI. While the House bill sat in the Health and Human Services Committee, a hearing for SB 490 was held February 28 before the Senate Public Health and Welfare Committee. No formal verdict has been publicized, but the American Optometric Association reports that the bill isn’t moving forward.

**West Virginia.** After losing a scope battle in 2023, West Virginia ODs experienced a disappointing feeling of déjà vu when this year’s legislative session came to a close before the Senate had a chance to weigh in on laser bill HB 4783, effectively ending its run this year. In February, the bill—which included minor and surgical procedures such as lesion removal, capsulotomy, SLT and LPI—had scored a big win in the House, receiving a 91-2 vote in favor of the legislation. Hopefully, this strong bipartisan support will carry over when the bill ends up back in the hands of the legislature, most likely next year. ◀



The Assembly Regulated Professions Committee voted 6-0 in favor of New Jersey’s laser bill, A-920, on March 14. Several optometrists testified during the hearing, including Drs. Kelley Sedlock, Chris Quinn and Jessica Garden, pictured here from left to right.

Photo: NJSOP

# FEATURES

REVIEW OF OPTOMETRY • Vol. 161, No. 4 • APRIL 15, 2024

## PRACTICE MANAGEMENT

### 36 Building a Top-flight Staff

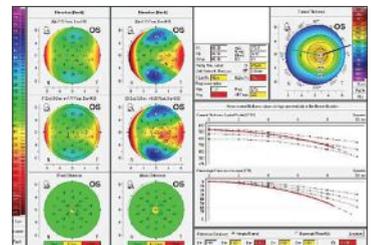
A successful optometry practice requires a dedicated, passionate team and effective leadership. Here's how to land ideal candidates and foster a positive office environment to keep them there long-term. *By Catlin Nalley, Contributing Editor*



## 11TH ANNUAL CORNEA REPORT

### 40 Sizing Up Keratoconus: The Roles of Topography and Tomography

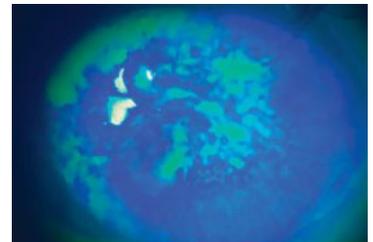
Three different imaging modalities serve their own purposes for diagnosing and monitoring this condition. *By Julie Song, OD*



### 52 Corneal Cases: Which are Right For You?

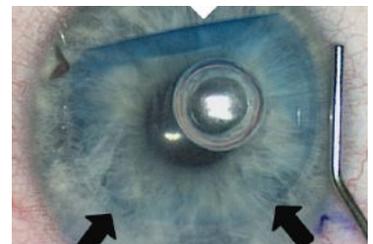
Here's how to evaluate a wide array of presentations and decide whether to accept or send to another provider.

*By Christina Cherny, OD, and Suzanne Sherman, OD*



### 60 Advances in Endothelial Surgery: An Update for ODs

DMEK remains the current procedure of choice, but newer techniques may obviate the need for donor tissue entirely. Read on to learn the current state of the art and, perhaps, glimpse the future. *By Kathleen Kelley, OD, Francis Price Jr., MD, and Marianne Price, PhD*



### 66 Corneal Pain Presentations: Causes and Interventions

Get up to speed on the basis and manifestations of neuropathic as well as neurotrophic changes. *By Daniel Grangaard, OD, William Hileman, OD, and Steve Njeru, OD*

—EARN 2 CE CREDITS



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# Could it be KC (KERATOCONUS)?

## KC File #2: Autorefractor Clues That Were Ignored

**Susan J. “Super Sleuth” Gromacki, OD, MS, FAAO, FSLs**, First Sight Vision Care  
Dr. Gromacki is a paid consultant for Glaukos.



**A** young woman who had relocated to my area for her first job after college was referred to me by the hometown optometrist who had seen her regularly since childhood. She was a high myope, wearing a spectacle prescription of -4.75 sphere OD and -9.25 -1.25 x003 OS.

The optometrist’s records showed a slow but steady decline in best-corrected visual acuity (BCVA). This went unremarked until 2022, when the patient’s OS could not be corrected even to 20/30. At that point, she was referred to a retina specialist, who ruled out a suspected epiretinal membrane and reported other findings all within normal limits.

In retrospect, there were three clues that could have alerted the practitioner to the possibility of keratoconus. First, when a young person can’t be corrected to 20/20, the cornea is a more likely culprit than the retina. The patient’s vision in the left eye hadn’t been a sharp 20/20 for several years. Secondly, an increase of 0.5 D of astigmatism between annual visits is a significant red flag. And finally, another clue came from the simplest diagnostic tool in the office—the autorefractor. The autorefraction in 2022 showed 2.75 D of astigmatism—a full diopter more than the spectacle prescription—and the quality score was only 8 out of 10. I would expect it to be 10/10 in a healthy young person.

A history of “lazy eye” as a child may be why the declining BCVA in her left eye was not taken very seriously at first. This was noted in her chart, although there was no evidence of binocular vision testing, no mention of exophoria or esophoria, and she didn’t have the typical hyperopic refraction we usually see in a lazy eye. Sometimes practitioners label a worse-seeing eye as a “lazy eye.” While this certainly may be the case, that label threw off her long-time optometrist. The clues could have led the optometrist to a KC diagnosis.

In 2023, when I first saw this patient, corneal topography showed 2.80 D of astigmatism OS with a classic pattern of inferior steepening that is pathognomonic for progressive KC. She was treated with iLink® corneal cross-linking in the left eye and we continue to follow her right eye closely because KC is a bilateral, asymmetric, disease. Recently the patient shared with me that her uncle has KC, something she didn’t know when I asked her initially.

**By following the KC clues that are hiding in plain sight, you can help patients like this one avoid years of declining vision—and sleuth out the right specialists to treat the underlying progressive condition that is stealing her sight. Visit [iDetectives.com](https://www.idetectives.com) to learn more.**

### #FollowTheClues



**INDICATIONS** Photrexa® Viscous (riboflavin 5'-phosphate in 20% dextran ophthalmic solution) and Photrexa® (riboflavin 5'-phosphate ophthalmic solution) are indicated for use with the KXL System in corneal collagen cross-linking for the treatment of progressive keratoconus and corneal ectasia following refractive surgery.

**IMPORTANT SAFETY INFORMATION** Corneal collagen cross-linking should not be performed on pregnant women. Ulcerative keratitis can occur. Patients should be monitored for resolution of epithelial defects. The most common ocular adverse reaction was corneal opacity (haze). Other ocular side effects include punctate keratitis, corneal striae, dry eye, corneal epithelium defect, eye pain, light sensitivity, reduced visual acuity, and blurred vision. These are not all of the side effects of the corneal collagen cross-linking treatment. For more information, go to [www.livingwithkeratoconus.com](http://www.livingwithkeratoconus.com) to obtain the FDA-approved product labeling.

You are encouraged to report all side effects to the FDA. Visit [www.fda.gov/medwatch](http://www.fda.gov/medwatch), or call 1-800-FDA-1088.

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### KC File #2: **THE CLUES**

- A surprising autorefraction with a low reliability score
- History of “lazy eye”
- Doesn't correct to 20/20
- 0.5 D increase in astigmatism in 1 year

### Changing refractive astigmatism and vision:

YEAR	DC	BCVA
2014	1.00	20/20
2015	1.25	20/20
2017	1.25	20/20
2018	1.25	20/20-1
2019	1.25	20/25
2021	1.25	20/20-2
2022	1.75	20/30-1
2023	2.25	20/30



**iDetective**  
Following the clues  
for early KC detection

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## NEWS REVIEW

Clinical, legislative and practice updates for ODs.

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## OUTLOOK

### Attack of the Clones

All tools may be able to imitate some of a doctor's skills, but they come up short where it really matters.

**Jack Persico, Editor-in-Chief**

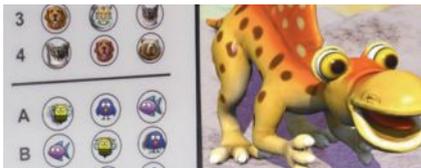
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## FOCUS ON REFRACTION

### To See in 3D

A review of stereo tests.

**Pamela Schnell, OD, and Marc Taub, OD**



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### Big Things in Small Packages

A new extended-release drug delivery device can help tremendously with compliance—at a price.

**Paul C. Ajamian, OD**

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## THROUGH MY EYES

### Corneal and Allergy Conundrums

Let's dive into both worlds and explore new treatments.

**Paul M. Karpecki, OD**

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## CHAIRSIDE

### What's Your Plan?

Make patients see better. It's as simple as that.

**Montgomery Vickers, OD**

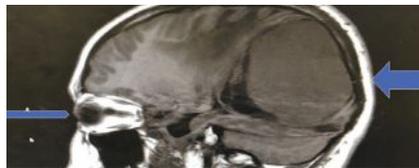
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## YOU BE THE JUDGE

### Flashes? Think Beyond the Retina

Limiting your exam of a patient who presents with this complaint can prove to be disastrous.

**Jerome Sherman, OD, and Sherry Bass, OD**



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### Twin Tumor Therapies

Ocular consequences of new cancer drugs.

**Jessica Steen, OD**

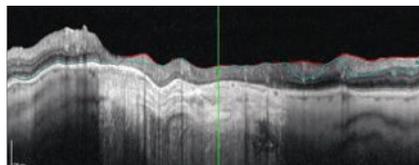
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## GLAUCOMA GRAND ROUNDS

### Enough Data to Track Glaucoma Patients?

It can be challenging to obtain adequate info when fundamental damage markers are blocked.

**James L. Fanelli, OD**



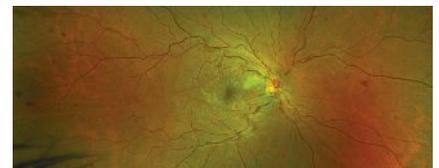
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## RETINA QUIZ

### Closed Off

This condition is rarely seen in a typical healthy population.

**Rami Aboumourad, OD**



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## SURGICAL MINUTE

### Hot Topic

Same-day bilateral cataract surgery, while controversial, is making waves worldwide.

**Derek N. Cunningham, OD, and Walter O. Whitley, OD, MBA**



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## DIAGNOSTIC QUIZ

### The Enemy Within

A patient presents with anterior uveitis as well as several systemic conditions, plus retinal detachment. What's going on?

**Andrew S. Gurwood, OD**



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Is a lipophilic agent in an aqueous drop that...



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chloride channels to...



Target, paralyze, and kill *Demodex* mites

GABA=gamma-aminobutyric acid.

#### INDICATIONS AND USAGE

XDEMVI (lotilaner ophthalmic solution) 0.25% is indicated for the treatment of *Demodex* blepharitis.

#### IMPORTANT SAFETY INFORMATION:

#### WARNINGS AND PRECAUTIONS

**Risk of Contamination:** Do not allow the tip of the dispensing container to contact the eye, surrounding structures, fingers, or any other surface in order to minimize contamination of the solution. Serious damage to the eye and subsequent loss of vision may result from using contaminated solutions.

**Use with Contact Lenses:** XDEMVI contains potassium sorbate, which may discolor soft contact lenses. Contact lenses should be removed prior to instillation of XDEMVI and may be reinserted 15 minutes following its administration.

#### Real results



44% and 55% of patients taking XDEMVI in SATURN-1 (N=209) and SATURN-2 (N=193), respectively, achieved a significant improvement in their eyelids (reduction of collarettes to no more than 2 collarettes per upper lid) at Day 43 vs 7% (N=204) and 12% (N=200) of patients taking vehicle ( $P < 0.01$  in each trial).<sup>1\*</sup>

All images are of actual patients who participated in clinical trials for Tarsus Pharmaceuticals.

**ADVERSE REACTIONS:** The most common adverse reaction with XDEMVI was instillation site stinging and burning which was reported in 10% of patients. Other ocular adverse reactions reported in less than 2% of patients were chalazion/hordeolum and punctate keratitis.

**Please see next page for a Brief Summary of the full Prescribing Information.**

**References:** 1. XDEMVI [prescribing information]. Tarsus Pharmaceuticals, Inc; 2023. 2. Gao YY et al. *Invest Ophthalmol Vis Sci.* 2005;46(9):3089-3094. 3. Yeu E et al. *Cornea.* 2022;42:435-443. 4. Toutain CE et al. *Parasit Vectors.* 2017;10(1):522.

\*The safety and efficacy of XDEMVI for the treatment of DB were evaluated in a total of 833 patients (415 of whom received XDEMVI) in two 6-week, randomized, multicenter, double-masked, vehicle-controlled studies (SATURN-1 and SATURN-2). Patients were randomized to either XDEMVI or vehicle at a 1:1 ratio, dosed twice daily in each eye for 6 weeks. All patients enrolled were diagnosed with DB. The primary efficacy endpoint was defined as the proportion of patients with collarette reduction to no more than 2 collarettes per upper eyelid at Day 43.

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**XDEMYV® (lotilaner ophthalmic solution) 0.25%, for topical ophthalmic use**

**BRIEF SUMMARY OF PRESCRIBING INFORMATION**

Please see the XDEMYV® package insert for full Prescribing Information.

**INDICATIONS AND USAGE**

XDEMYV is indicated for the treatment of Demodex blepharitis.

**CONTRAINDICATIONS**

None.

**WARNINGS AND PRECAUTIONS**

**Risk of Contamination** Do not allow the tip of the dispensing container to contact the eye, surrounding structures, fingers, or any other surface in order to minimize contamination of the solution. Serious damage to the eye and subsequent loss of vision may result from using contaminated solutions.

**Use with Contact Lenses** Contact lenses should be removed prior to instillation of XDEMYV and may be reinserted 15 minutes following its administration.

**ADVERSE REACTIONS**

Because clinical studies are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

XDEMYV was evaluated in 833 patients with Demodex blepharitis in two randomized, double-masked, vehicle-controlled studies (Saturn-1 and Saturn-2) with 42 days of treatment. The most common ocular adverse reaction observed in controlled clinical studies with XDEMYV was instillation site stinging and burning which was reported in 10% of patients. Other ocular adverse reactions reported in less than 2% of patients were chalazion/hordeolum and punctate keratitis.

**USE IN SPECIFIC POPULATIONS**

**Pregnancy: Risk Summary** There are no available data on XDEMYV use in pregnant women to inform any drug associated risk; however, systemic exposure to lotilaner from ocular administration is low. In animal reproduction studies, lotilaner did not produce malformations at clinically relevant doses.

**Data Animal Data** In an oral embryofetal developmental study in pregnant rats dosed during organogenesis from gestation days 6-19, increased post-implantation loss, reduced fetal pup weight, and incomplete skeletal ossification were observed at 50 mg/kg/day (approximately 1390 times the recommended human ophthalmic dose (RHOD) on a body surface area basis) in the presence of maternal toxicity (i.e., decreased body weight and food consumption). A rare malformation of situs inversus of the thoracic and abdominal viscera occurred in 1 fetus from a pregnant rat receiving 50 mg/kg/day; whether this finding was treatment-related could not be excluded. No maternal or embryofetal toxicity was observed at 18 mg/kg/day (approximately 501 times the RHOD on a body surface area basis). In an oral embryofetal development study in pregnant rabbits dosed during organogenesis from gestation days 7-19, no embryofetal toxicity or teratogenic findings were observed at 20 mg/kg/day (approximately 580-times the RHOD on an AUC basis), even in the presence of maternal toxicity (i.e., decreased food consumption and body weight).

In an oral two-generation reproductive toxicity study, F0 male and female rats were administered lotilaner at doses up to 40 mg/kg/day for 10 weeks before pairing and during the 2-week pairing period (3 weeks for males). Dosing for F0 females continued through lactation day 22. F1 male and female rats were administered lotilaner at 1 and 5 mg/kg/day post-weaning from day 23 for 10 weeks before pairing and during the 2-week pairing period (3 weeks for males). Dosing for F1 parenteral females continued through lactation day 22.

There were no clear adverse effects on the F1 generation, and a slightly lower mean body weight during lactation was noted for F2 pups at 5 mg/kg/day. The observed adverse effect level (NOAEL) was determined to be 5 mg/kg/day

(approximately 139 times the RHOD on a body surface area basis).

**Lactation: Risk Summary** There are no data on the presence of XDEMYV in human milk, the effects on the breastfed infant, or the effects on milk production. However, systemic exposure to lotilaner following 6 weeks of topical ocular administration is low and is >99% plasma protein bound, thus it is not known whether measurable levels of lotilaner would be present in maternal milk following topical ocular administration. The developmental and health benefits of breastfeeding should be considered along with the mother's clinical need for XDEMYV and any potential adverse effects on the breast-fed child from XDEMYV.

**Pediatric Use:** Safety and effectiveness in pediatric patients below the age of 18 years have not been established.

**Geriatric Use:** No overall differences in safety or effectiveness have been observed between elderly and other adult patients.

**NONCLINICAL TOXICOLOGY**

**Carcinogenesis, Mutagenesis, Impairment of Fertility**

**Carcinogenesis** Long-term studies in animals have not been performed to evaluate the carcinogenic potential of lotilaner.

**Mutagenesis** Lotilaner was not genotoxic in the following assays: Ames assay for bacterial gene mutation, *in vitro* chromosomal aberration assay in cultured human peripheral blood lymphocytes, and *in vivo* rat micronucleus test.

**Impairment of fertility** In a two-generation study of reproductive performance in rats, F0 male and female rats were administered lotilaner at oral doses of 40 mg/kg/day for 80 days reduced to 20 mg/kg/day for 47-50 supplementary days. Reduced pregnancy rates and decreased implantation rates were observed in F0 females at doses 20 mg/kg/day (approximately 556 times the RHOD on a body surface area basis), which were also associated with maternal toxicity (i.e., decreased body weight and food consumption). No effects on fertility were observed in F0 females at the dose of 5 mg/kg/day (approximately 139 times the MRHOD on a body surface area basis). No effects on fertility were observed in F0 males at the oral dose of 20 mg/kg/day (approximately 556 times the RHOD on a body surface area basis), and no effects on fertility were observed in F1 males and females at the oral dose of 5 mg/kg/day (approximately 139 times the RHOD on a body surface area basis).

**PATIENT COUNSELING INFORMATION**

**Handling the Container** Instruct patients to avoid allowing the tip of the dispensing container to contact the eye, surrounding structures, fingers, or any other surface in order to minimize contamination of the solution. Serious damage to the eye and subsequent loss of vision may result from using contaminated solutions.

**When to Seek Physician Advice**

Advise patients that if they develop an intercurrent ocular condition (e.g., trauma or infection), have ocular surgery, or develop any ocular reactions, particularly conjunctivitis and eyelid reactions, they should immediately seek their physician's advice concerning the continued use of XDEMYV.

**Use with Contact Lenses** Advise patients that XDEMYV contains potassium sorbate, which may discolor soft contact lenses. Contact lenses should be removed prior to instillation of XDEMYV and may be reinserted 15 minutes following its administration.

**Use with Other Ophthalmic Drugs** Advise patients that if more than one topical ophthalmic drug is being used, the drugs should be administered at least 5 minutes between applications.

**Missed Dose** Advise patients that if one dose is missed, treatment should continue with the next dose.

RX only

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US-2300345 1/24

# REVIEW of OPTOMETRY

Leadership in clinical care

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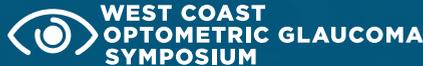
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BY JACK PERSICO  
EDITOR-IN-CHIEF  
**OUTLOOK**

# Attack of the Clones

*Artificial intelligence tools may be able to imitate some of a doctor's skills, but they come up short where it really matters.*

In 1961, chemist Otto Wichterle realized that a disc of hydrogel material could be shaped with different front and back surface curvatures by spinning the mold during polymerization—and thus the soft contact lens was born. He did so by building a makeshift contraption from an Erector set and a record player's motor. In 1964, ophthalmologist Charles Kelman dreamed up phacoemulsification while at the dentist. The ultrasonic probe used to clean his teeth inspired him to create a similar device that could break up an opacified crystalline lens in a controlled manner. In 1991 a laser engineer, a satellite communications expert and an ophthalmologist pooled their differing areas of expertise to collaboratively develop optical coherence tomography.

These are just three examples of the rich history of innovation that made eye care what it is today. In each, success was achieved through a combination of inspiration, ingenuity and just plain chutzpah. You know what doesn't have any of those? Your computer.

As in so many other walks of life, eye care seems ready to be disrupted by artificial intelligence. The topic has exploded this year, with a series of journal articles showing ChatGPT and other AI tools generally did well in replicating the work of cornea, glaucoma and retina specialists in diagnosis, clinical decision-making and patient education. This news fills some doctors with dread. The conversation around AI's forthcoming impact in eye care is oddly bipolar: hype in some corners, hand-wringing in others. Reality surely lies somewhere in between.

I think we've all seen by now that AI-generated content is a bit wild and wooly. The most public recent example

was Google Gemini's heavy-handed push for diversity it its photo creation tools, leading to some hilarious and cringe-worthy results. But others can come from an AI process that scrapes data from the internet and uses it as a source. Last fall, a chatbot on the discussion board Quora inexplicably answered yes to the question, "Can you melt an egg?" and this foolish answer was picked up by Google, which started repeating it. The ensuing online discussion then lent it credence and gave it more reach. This kind of feedback loop is just one way that misinformation propagates online.

So, AI clearly has some growing pains to go through before it'll be ready for prime time. Pop culture has trained us to expect AI to be either amazingly useful or unrelentingly evil. "Gullible and inept" is kind of a new one. Any implementation of AI in eye care that uses public input, like queries about—and, good lord, users' own explanations of—eye diseases and surgeries is going to be a bit of a mess. More useful will be tools built upon valid datasets to help simplify disease diagnosis for professionals. I could see those being hugely helpful in developing nations where there's a dire lack of doctors and equipment. Here at home will be a different story. There's too much institutional inertia in the American healthcare system for AI to run wild.

AI tools will eventually do amazing things in eye care. But they'll never give us contact lenses, phaco or OCT. That takes human audacity. They also won't be able to make eye contact with a worried patient and reassuringly explain a tricky diagnosis. Chatbots may be able to spit out a paragraph on a disease, but they can't help a patient cope and move on. Only you can do that. ■

IYUZEH™ (latanoprost ophthalmic solution) 0.005% is the first and only preservative-free latanoprost for patients with primary open-angle glaucoma (POAG) and ocular hypertension (OHT).

iyuzeh™  
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*We owe it to our patients with elevated intraocular pressure, with open-angle glaucoma or ocular hypertension to provide a new evidence-based approach. It is an extremely exciting time to prescribe IYUZEH™ for my patients.*

**Monique M. Barbour, MD, MHA, FAAO**

Dr. Barbour is a paid consultant of Thea Pharma Inc.



## INDICATIONS AND USAGE

IYUZEH™ is a prostaglandin analogue indicated for the reduction of elevated intraocular pressure in patients with open-angle glaucoma or ocular hypertension.

## IMPORTANT SAFETY INFORMATION

### CONTRAINDICATIONS

Known hypersensitivity to latanoprost or any other ingredients in this product.

### WARNINGS AND PRECAUTIONS

**Pigmentation:** Topical latanoprost ophthalmic products, including IYUZEH™ have been reported to cause changes to pigmented tissues. The most frequently reported changes have been increased pigmentation of the iris, periorbital tissue (eyelid), and eyelashes. Pigmentation is expected to increase as long as latanoprost is administered.

The pigmentation change is due to increased melanin content in the melanocytes rather than to an increase in the number of melanocytes. After discontinuation of latanoprost, pigmentation of the iris is likely to be permanent, while pigmentation of the periorbital tissue and eyelash changes have been reported to be reversible in some patients. Patients who receive treatment should be informed of the possibility of increased pigmentation. The long-term effects of increased pigmentation are not known.

Iris color change may not be noticeable for several months to years. Typically, the brown pigmentation around the pupil spreads concentrically towards the periphery of the iris and the entire iris or parts of the iris become more brownish. Neither nevi nor freckles of the iris appear to be affected by treatment. While treatment with IYUZEH™ can be continued in patients who develop noticeably increased iris pigmentation, these patients should be examined regularly.

**Eyelash Changes:** Latanoprost ophthalmic products, including IYUZEH™ may gradually change eyelashes and vellus hair in the treated eye; these changes include increased length, thickness, pigmentation, the number of lashes or hairs, and misdirected growth of eyelashes. Eyelash changes are usually reversible upon discontinuation of treatment.

**Intraocular Inflammation:** IYUZEH™ should be used with caution in patients with a history of intraocular inflammation (iritis/uveitis) and should generally not be used in patients with active intraocular inflammation because inflammation may be exacerbated.

**Macular Edema:** Macular edema, including cystoid macular edema, has been reported during treatment with latanoprost ophthalmic products, including IYUZEH™. IYUZEH™ should be used with caution in aphakic patients, in pseudophakic patients with a torn posterior lens capsule, or in patients with known risk factors for macular edema.

**Herpetic Keratitis:** Reactivation of herpes simplex keratitis has been reported during treatment with latanoprost. IYUZEH™ should be used with caution in patients with a history of herpetic keratitis. IYUZEH™ should be avoided in cases of active herpes simplex keratitis because inflammation may be exacerbated.

**Contact Lens Use:** Contact lenses should be removed prior to the administration of IYUZEH™ and may be reinserted 15 minutes after administration.

### ADVERSE REACTIONS

The following adverse reactions have been reported with the use of topical latanoprost products: iris pigmentation changes, eyelid skin darkening, eyelash changes (increased length, thickness, pigmentation, and number of lashes), intraocular inflammation (iritis/uveitis), and macular edema, including cystoid macular edema.

### DRUG INTERACTIONS

The combined use of two or more prostaglandins, or prostaglandin analogs including IYUZEH™ is not recommended. It has been shown that administration of these prostaglandin drug products more than once daily may decrease the IOP lowering effect or cause paradoxical elevations in IOP.

**Please see full Prescribing Information at [www.iyuzeh.com](http://www.iyuzeh.com) and Brief Summary on the next page.**

Explore the power of preservative-free latanoprost at [iyuzeh.com](http://iyuzeh.com)



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# iyuzeh<sup>TM</sup>

(latanoprost ophthalmic solution) 0.005%

## HIGHLIGHTS OF PRESCRIBING INFORMATION

This brief summary does not include all the information needed to use IYUZEH safely and effectively. See full prescribing information for IYUZEH.

Initial U.S. Approval: 2022

### INDICATIONS AND USAGE

IYUZEH is a prostaglandin F<sub>2α</sub> analogue indicated for the reduction of elevated intraocular pressure in patients with open-angle glaucoma or ocular hypertension.

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**Contact Lens Use:** Contact lenses should be removed prior to the administration of IYUZEH and may be reinserted 15 minutes after administration.

### ADVERSE REACTIONS

The following adverse reactions have been reported with the use of topical latanoprost products and are discussed in greater detail in the prescribing information:

- Iris pigmentation changes
- Eyelid skin darkening
- Eyelash changes (increased length, thickness, pigmentation, and number of lashes)
- Intraocular inflammation (iritis/uveitis)
- Macular edema, including cystoid macular edema

Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

In the two clinical trials conducted with IYUZEH (latanoprost ophthalmic solution) 0.005% comparing it to XALATAN the preserved 0.005% latanoprost reference product, the most frequently reported ocular adverse reactions were conjunctival hyperemia and eye irritation (Table 1).

Table 1. Adverse Reactions

Symptom/Finding	Adverse Reactions [n (%)]	
	IYUZEH (n=378)	XALATAN (n=358)
Conjunctival hyperemia	129 (34)	133 (37)
Eye irritation	72 (19)	112 (31)
Eye pruritus	57 (15)	58 (16)
Abnormal sensation in eyes	51 (14)	52 (15)
Foreign body sensation in eyes	44 (12)	36 (10)
Vision blurred	28 (7)	30 (8)
Lacrimation increased	19 (5)	14 (4)
Photophobia	13 (3)	17 (5)

### POSTMARKETING EXPERIENCE

The following adverse reactions have been identified during post-approval use of topical latanoprost products. Because these reactions are reported voluntarily from a population of uncertain size, it is not always possible to reliably estimate their frequency or establish a causal relationship to drug exposure. The reactions, which have been chosen for inclusion due to either their seriousness, frequency of reporting, possible causal connection to ophthalmic latanoprost products, or a combination of these factors, include:

- Nervous System Disorders: Dizziness; headache; toxic epidermal necrolysis
- Eye Disorders: Eyelash and vellus hair changes of the eyelid (increased length, thickness, pigmentation, and number of eyelashes); keratitis; corneal edema and erosions; intraocular inflammation (iritis/uveitis); macular edema, including cystoid macular edema; trichiasis; periorbital and lid changes resulting in deepening of the eyelid sulcus; iris cyst; eyelid skin darkening; localized skin reaction on the eyelids; conjunctivitis; pseudomphigoid of the ocular conjunctiva.
- Respiratory, Thoracic and Mediastinal Disorders: Asthma and exacerbation of asthma; dyspnea
- Skin and Subcutaneous Tissue Disorders: Pruritus
- Infections and Infestations: Herpes keratitis
- Cardiac Disorders: Angina; palpitations; angina unstable
- General Disorders and Administration Site Conditions: Chest pain

### DRUG INTERACTIONS

The combined use of two or more prostaglandins, or prostaglandin analogs including IYUZEH is not recommended, and administration of these prostaglandin drug products more than once daily may decrease the IOP lowering effect or cause paradoxical IOP elevations.

### USE IN SPECIFIC POPULATIONS

**Pregnancy:** There are no adequate and well-controlled studies of IYUZEH administration in pregnant women to inform drug-associated risks.

**Lactation:** It is not known whether this drug or its metabolites are excreted in human milk. Because many drugs are excreted in human milk, caution should be exercised when IYUZEH is administered to a nursing woman. The developmental and health benefits of breastfeeding should be considered along with the mother's clinical need for IYUZEH and any potential adverse effects on the breastfed child from IYUZEH.

**Pediatric Use:** The safety and effectiveness of IYUZEH have not been established in pediatric patients.

**Geriatric Use:** No overall differences in the safety or effectiveness of IYUZEH have been observed between elderly and younger adult patients.

### OVERDOSAGE

Intravenous infusion of up to 3 mcg/kg of latanoprost in healthy volunteers produced mean plasma concentrations 200 times higher than during clinical treatment with latanoprost ophthalmic solution and no adverse reactions were observed. IV dosages of 5.5 to 10 mcg/kg caused abdominal pain, dizziness, fatigue, hot flushes, nausea, and sweating.

### HANDLING THE CONTAINER

IYUZEH is a sterile solution that does not contain a preservative supplied in a single-dose container. The solution from one individual container is to be used immediately after opening for administration to one or both eyes. Since sterility cannot be maintained after the individual container is opened, the remaining contents should be discarded immediately after administration. Open a new single-dose container every time you use IYUZEH.

Manufactured for: Théa Pharma Inc. Waltham, MA.

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U.S. Patent N<sup>o</sup>. 8,637,054.

Revised: 04/2023

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BY PAMELA H. SCHNELL, OD, AND MARC B. TAUB, OD, MS, EdD

## FOCUS ON REFRACTION

# To See in 3D

A review of stereo tests.

We all have a tendency to slip into bad habits, especially as we aim for greater efficiency in our clinical exams. One test that some practitioners may overlook or omit in order to decrease chair time is stereopsis. Many practitioners perform stereo testing on new, younger patients but not established or adult patients in the belief that stereopsis does not change over time or that it is only needed in childhood. As we have observed, however, not only can stereo change, but regular assessment of stereo can provide insight into patients' overall comfort and binocular stability. Here, we offer you a review of four commonly used stereo tests and discuss their clinical usefulness.

## Functional Binocular Assessment Test (FBAT)

The FBAT (Bernell) is the new version of the older Keystone Basic Binocular Test (KBB) (*Figure 1*). Designed as a user-friendly flipbook, the FBAT is a red/green test that assesses all three



**Fig. 1.** FBAT jets showing local stereopsis demand.

levels of fusion: simultaneous perception (primary fusion), flat (secondary) fusion and stereopsis (tertiary fusion). With directions for each page written on the back of the next, the FBAT is easy to administer and requires only red/green glasses as additional equipment. While the test is typically used for toddler and preschool ages, we have used it on much younger patients by holding the red/green glasses ourselves and watching for a reaching reaction to perceived float of the targets. Even older infants will instinctively reach for engaging targets; the youngest patient who gave either of us a reaching response, attempting to grasp the hippo target and delighting her parents, was just four months old!

A few particularly useful features exist on the FBAT. One is that several of the targets include a black circle around the red/green images. This circle is viewed by both eyes through the filters, providing a binocular fusion lock that can help patients perceive the appropriate stereopsis by stabilizing alignment. Stable visual axes make stereo easier to achieve and maintain. Another helpful feature is that some pages include multiple targets of different retinal disparities (and therefore different levels of stereo), allowing the practitioner to assess the patient's flexibility. If they can jump quickly between targets and appreciate the appropriate depth, their vergence system is likely to be quite flexible indeed. A third clinically helpful feature is that at least one of the multiple-target pages includes images that are counter-intuitive in their respective sizes.



**Fig. 2.** The Lang II stereo test.

For example, we see two jet planes in *Figure 1*. Looking at the targets without the red/green glasses, it is easy to see there is greater disparity in the smaller of the two planes; when seen in stereo, this plane should float closer to the patient than the larger plane. Patients who suppress an eye's input and use monocular cues for depth, however, will report upon questioning that the larger of the two planes appears closer, since larger objects take up more retinal area, and we learn very early in life that this means "closer." We can easily tell whether a patient is suppressing if they give this response.

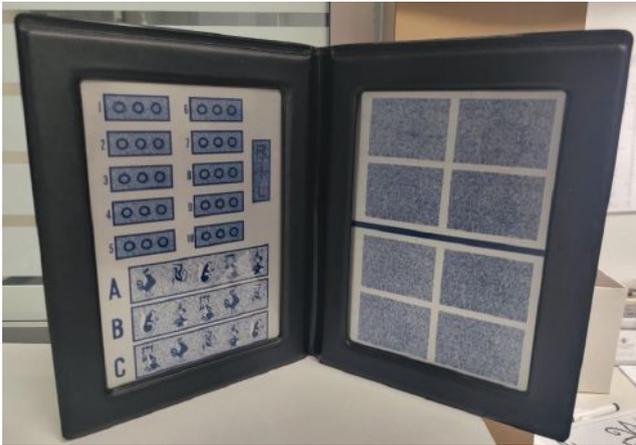
## Lang II

One difficulty that we occasionally face with younger patients is getting them to leave red/green or polarized glasses on for testing. The Lang Stereo Test (Bernell) is an option that does not require the use of glasses. It comes in two forms: Lang I and Lang II, which have targets of different stereo demand. I (PS) have carried a Lang II card with me for most of my 20+ years in practice and greatly appreciate its ease of use for youngsters.

The Lang II card (*Figure 2*) presents one demonstration and three global stereo targets; these are all in the form of kid-friendly pictures. Included in the

About  
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and Schnell

**Dr. Taub** is a professor and co-supervisor of the Vision Therapy and Pediatrics residency at Southern College of Optometry (SCO) in Memphis. He specializes in vision therapy, pediatrics and brain injury. **Dr. Schnell** is a professor at SCO and teaches courses on ocular motility and vision therapy. She works in the pediatric and vision therapy clinics and is co-supervisor of the Vision Therapy and Pediatrics residency. Her clinical interests include infant and toddler eye care, vision therapy, visual development and the treatment and management of special populations. They have no financial interests to disclose.



**Fig. 3. The Randot stereo test, showing both local and global targets.**

test are a star (demonstration only, seen monocularly), a car, an elephant and a moon. These targets range from 600 arcseconds (the elephant) to 200 arcseconds (the moon) of base-out demand. However, they are difficult to see if the patient isn't looking at them straight-on. This can lead to some interesting comments from parents, like, "Wow, I can't see that!"—it's a great way to suggest that they also schedule an exam.

There are two types of stereo: global and local. Local targets have distinct edges or borders; the Wirt circles in the standard Randot book are good examples. In contrast, global targets do not have distinct borders and instead are random-dot presentations. For those part of Generation X (like me) and Baby Boomers out there, these are the ones that look like the old TV "snow" patterns! Using global targets to test stereopsis requires the patient to use both foveae in order to see them. Because of this, global targets are especially useful for strabismus patients, as we can immediately tell whether or not a turn is constant or intermittent. If the patient achieves global stereo, they are aligned and using both foveae—at least for that moment.

**Randot**

This is the classic book that most of us acquired and used during our optometry training (Figure 3). Using polarized glasses, patients are presented with both local and global stereo targets that cover a wide range of demand. On one page,

there are Wirt circles, arranged either in groups of three or four, depending on the specific book you have. Local stereo demand can be as small as 20 arcseconds for these targets, providing a very precise assessment of stereo acuity. Since patients may give up when the targets become difficult to discern,

it's important to encourage them to keep guessing—they often are able to visualize depth in much finer increments than they realize.

One observation I have made over the years is that fine stereo often decreases prior to noticeable drops in visual acuity, so I find it helpful to test using Wirt circles every year and look closely for changes. The circles can also be used to determine immediate change with nearpoint prescriptions.

The other page of the Randot (Stereo Optical) book displays a series of shapes or forms, presented as global targets. Patients are asked to point out and to identify the shapes seen in the boxes; most books include four boxes on the top of the page with a 500 arcsecond demand and four boxes on the bottom with a 250 arcsecond demand. There is usually one "empty" box in each group of four that contains no discernible shape, which provides a check on whether patients are making up answers. For young patients who may not yet know the names of the various shapes, I find it useful to flip the book closed and have them match the shapes printed on the cover.

**Bernell Evaluation of Stereo Test (BEST)**

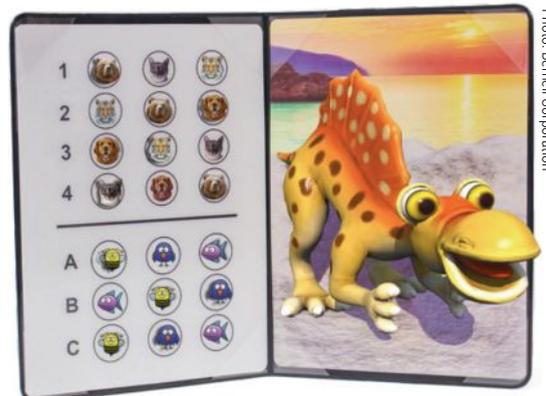
This newer stereo option is an especially kid-friendly test since it uses cartoon-style characters (Figure 4). All the targets on the BEST are local stereopsis,

created with lenticular technology that does not require glasses to produce the stereo effect. Additionally, it is the only test reviewed of the four here that is in color, which can better help in keeping kids' attention on the task.

On one page of the BEST, pictures of different animals are arranged in multiple rows of three. One animal in each row is neutral, one animal is a base-in target and one animal is a base-out target. Stereo demand on the top set (numbered one to four) ranges from 400 to 40 arcseconds; demand on the targets below (lettered A to C) goes down to 80 arcseconds. On the facing page, a large, friendly dinosaur greets patients with its head down and a big smile—no teeth! The stereo demand varies across this target, and most of my young patients giggle while trying to "catch" the dino's nose, ears, toes, etc. I find it a fun way to check stereo in the preschool population in particular.

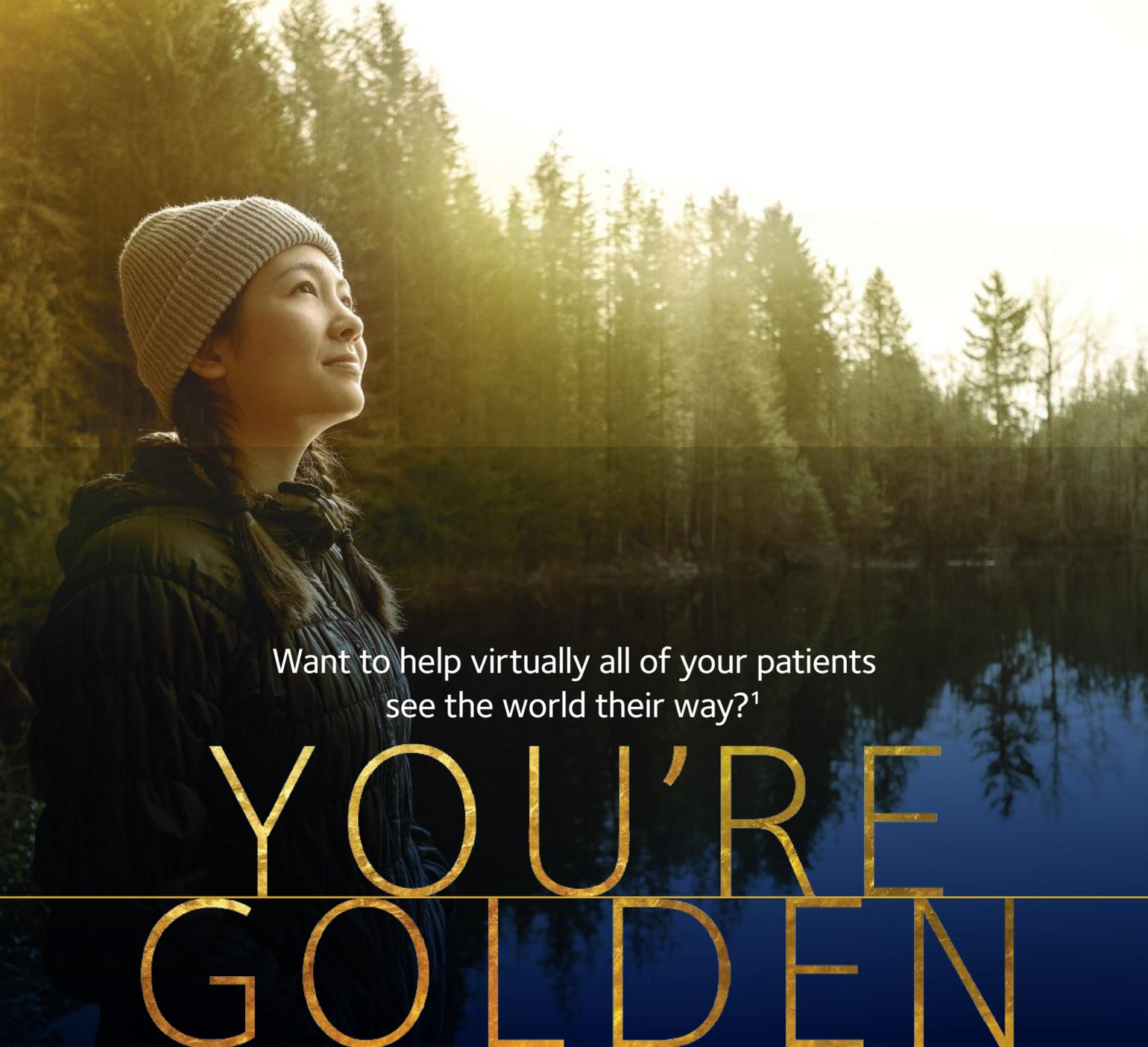
**Takeaways**

Although it may seem to be just another step in the exam sequence, one that takes time and may slow down clinical flow, stereo testing is actually fairly quick to perform and can provide important information, ranging from slight changes in visual status to differentiation between intermittent and constant strabismus. It can be easily taught to paraoptometric technicians, making its incorporation into your practice even more seamless. We recommend adding stereo back into your sequence—or continuing to include it! ■



**Fig. 4. BEST stereo test, dinosaur.**

Photo: Bernell Corporation



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1. CooperVision data on file 2021. Rx coverage database; 14–70 years.

2. CVI Data on file 2022. Based on global product sales and internal estimates of products using Aquaform® Technology over 12 months in 2022.

3. CVI data on file 2021. Decision Analyst online survey of 376 Biofinity prescribing ECPs in USA, Japan, Germany, France and Spain.

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EDITED BY PAUL C. AJAMIAN, OD

## CLINICAL QUANDARIES

# Big Things in Small Packages

*A new extended-release drug delivery device can help tremendously with compliance—if insurance covers the hefty price tag.*

**Q** I have an advanced glaucoma patient who won't comply with drops, has had SLT and yet continues to progress. What are my options?

**A** “Daily usage of eye drops can be very difficult for some patients,” says Arkadiy Yadgarov, MD, director of glaucoma services at Omni Eye Services of Atlanta. “There are myriad reasons for suboptimal compliance with glaucoma medications, but the most common include forgetfulness, ocular discomfort and difficulty obtaining the medicine due to cost. Additionally, hand-eye coordination becomes more challenging in the aging patient, and arthritis can add to that trial.”

With our patient, Dr. Yadgarov explains, the progressive OCT and field changes discovered during the examination were alarming and triggered an extensive discussion with the patient on disease severity and the ramifications of not pursuing a change in current management. Fortunately, compliance was identified as the primary issue. Adding more medicine usually leads to a further decrease in compliance.

Surgical interventions are classically the next step in stabilizing glaucoma in patients who are poorly compliant. Current options include invasive procedures such as tube shunts and trabeculectomy, which are powerful and effective but rife with complications and adverse effects. Standalone minimally invasive glaucoma surgery (MIGS) procedures such



Photo: Glaukos

**The iDose as seen implanted in the eye.**

as Omni or iStent infinite are newer and safer options, with minimal side effects and complications. A drawback of MIGS is achievement of adequate IOP reduction can often be unpredictable, and the treatment effects can wane quickly. Medicines are typically safe and have a predictable dose-dependent response, but compliance is the biggest concern. Dr. Yadgarov points out that an innovative solution to providing a safe and predictable way to lower pressure is to facilitate release of medicine into the eye without the need for patient involvement.

### Drug Delivery

Durysta (Allergan) was the first step in that direction. Approved in 2020, it is an in-office injectable implant that slowly releases bimatoprost intracamerally. The therapeutic effect is relatively short-lived, with IOP reduction that is greatest in the first six months and wanes after that. A second implant is typically not recommended or covered by insurance.

In December 2023, the iDose TR (travoprost intracameral implant 75mcg, Glaukos) was approved by the FDA.

iDose is an implant, similar to the iStent, which contains a prostaglandin analog (travoprost rather than bimatoprost in this case). Once the implant is seated into the trabecular meshwork, the travoprost medication is released slowly over an average period of three years.<sup>1</sup>

The FDA label allows for a single administration of iDose per eye to reduce IOP in patients with ocular hypertension or open-angle glaucoma. While the FDA has not yet allowed for a replacement device at the end of 36 months, current studies are underway to evaluate outcomes of implant replacement every three years. At 12 months, 81% of iDose TR subjects were completely free of IOP-lowering topical medications. iDose TR demonstrated excellent tolerability as well. The most common ocular adverse reactions reported in 2% to 6% of iDose TR patients were increases in intraocular pressure, iritis, dry eye and visual field defects, most of which were mild and transient.<sup>2</sup>

“Cost is the major issue of the implant, with a hefty price tag of \$14,000,” Dr. Yadgarov says. “Patients with traditional Medicare with supplemental insurance will have the best coverage, but it will take some time for reimbursement to kick in.”

Dr. Yadgarov is one of the first surgeons in the country to implant the device on carefully chosen patients and says he looks forward to the results as he follows these patients over time. He advises that those interested in the device should speak to their local glaucoma specialist to come up with a game plan that will best help the patient. ■

1. Glaukos announces FDA approval of iDose TR (travoprost intracameral implant) news release. [investors.glaukos.com/investors/news/news-details/2023/glaukos-announces-fda-approval-of-idosetr-travoprost-intracameral-implant/default.aspx](https://investors.glaukos.com/investors/news/news-details/2023/glaukos-announces-fda-approval-of-idosetr-travoprost-intracameral-implant/default.aspx). Published Dec. 14, 2023. Accessed December 14, 2023.

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About Dr. Ajamian

Dr. Ajamian is board certified by the American Board of Optometry and serves as Center Director of Omni Eye Services of Atlanta. He is vice president of the Georgia State Board of Optometry and general CE chairman of SECO International. He has no financial interests to disclose.

APRIL 2024

# THE VALUE OF REAL TEARS



## **Francis Mah, MD**

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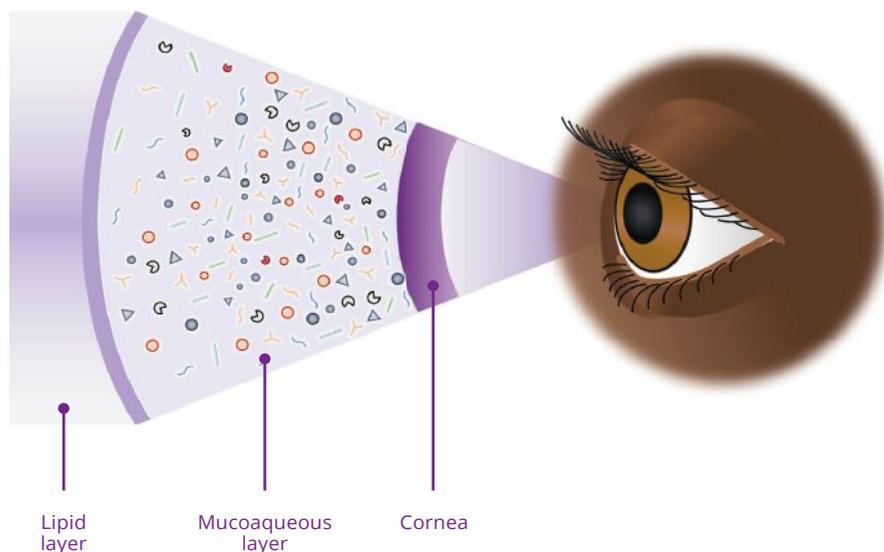
The ocular surface is constantly undergoing desiccating stress but, under normal circumstances, is protected from damage by the production of a stable, homeostatic tear film.<sup>1</sup> Therefore, restoring tear film homeostasis is a major goal of dry eye management, and the patient's ability to produce real tears of sufficient quality and quantity should be taken into account when starting dry eye treatment.<sup>2,3</sup>



**Tear film instability is a central driver of the complex cascade leading to clinical signs and symptoms of dry eye disease.**

Jessica Steen, OD, FAAO

One of the reasons that a stable tear film is important is because it accounts for the majority of the refractive power of the eye, with tear film instability leading to reduced contrast sensitivity and increased optical aberrations.<sup>3</sup> A stable tear film also provides lubrication, protection, and nourishment to maintain a healthy ocular surface and has been a noticeable feature of many definitions of dry eye throughout the years (**Figure 1**).<sup>4-7</sup>



**FIGURE 1:** A stable tear film accounts for the majority of the refractive power to the eye and the compounds found in the tear film provide lubrication, protection, and nourishment to the ocular surface.<sup>3,4</sup>

Almost all the definitions that have been proposed for dry eye, including those promulgated by TFOS DEWS II (2017) and the Global Consensus group (2020), have highlighted the idea that dry eye progression is driven by a cycle of tear film instability, hyperosmolarity, ocular surface damage, and inflammation.<sup>7,8</sup> Tear film stability can be compromised by decreased tear secretion, delayed tear clearance, and/or altered tear composition, which starts the cycle of dry eye and subsequently leads to the loss of homeostasis and ocular surface inflammation.<sup>1,9,10</sup>

**GLOBAL CONSENSUS  
DEFINITION (2020)**

**“Dry eye is a multifactorial disease characterized by a persistently unstable and/or deficient tear film causing discomfort and/or visual impairment, accompanied by variable degrees of ocular surface epitheliopathy, inflammation, and neurosensory abnormalities.”<sup>7</sup>**



**An unstable tear film is a critical initial step causing the downward spiral of the ocular surface leading to dry eye, tissue damage, and inflammation.**

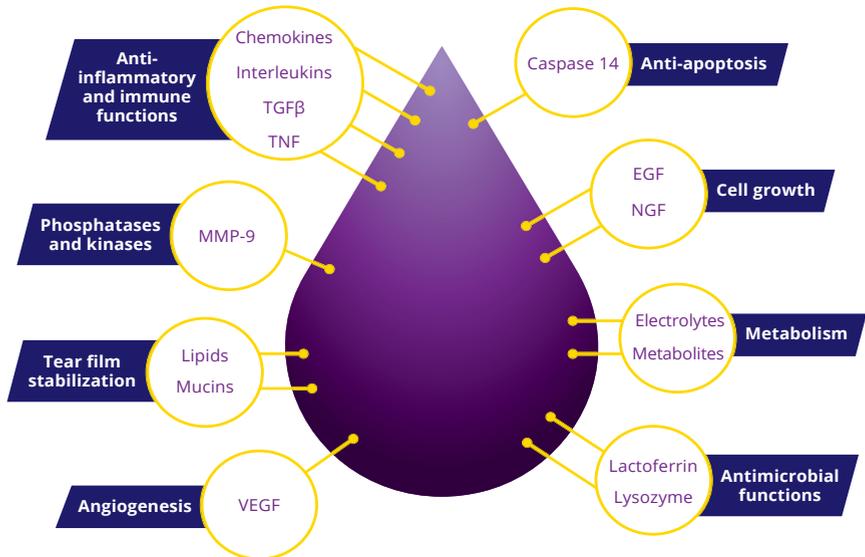
Francis Mah, MD

Tears are a complex mixture of elements and can come in four different types (basal, reflex, emotional, and closed-eye), each of which has a slightly different composition and function.<sup>4-6,11,12</sup> Basal tears are those that are present during the waking hours and are constantly being turned over. They are considered the primary tear that helps to maintain a healthy, functional ocular surface. Physical stimuli (eg, foreign bodies, trauma) to the eye produce a larger volume tear which is termed a reflex tear. Similarly, emotional stimuli (eg, sadness) also produce a larger volume tear called an emotional tear. The final tear type is the closed-eye tear that is produced when the eye is closed during a sleep cycle.<sup>11,12</sup>

Real tears, including basal tears, contain a complex milieu of over 2000 different components, each of which contributes to tear film stability and function (**Figure 2**). Among the many different components found in the tear film are proteins that protect the ocular surface and help it function (eg, growth factors, anti-inflammatory proteins), electrolytes and metabolites that play a role in basic cell metabolism, and mucins and lipids that help maintain tear film stability.<sup>4-6</sup>

**FIGURE 2:**

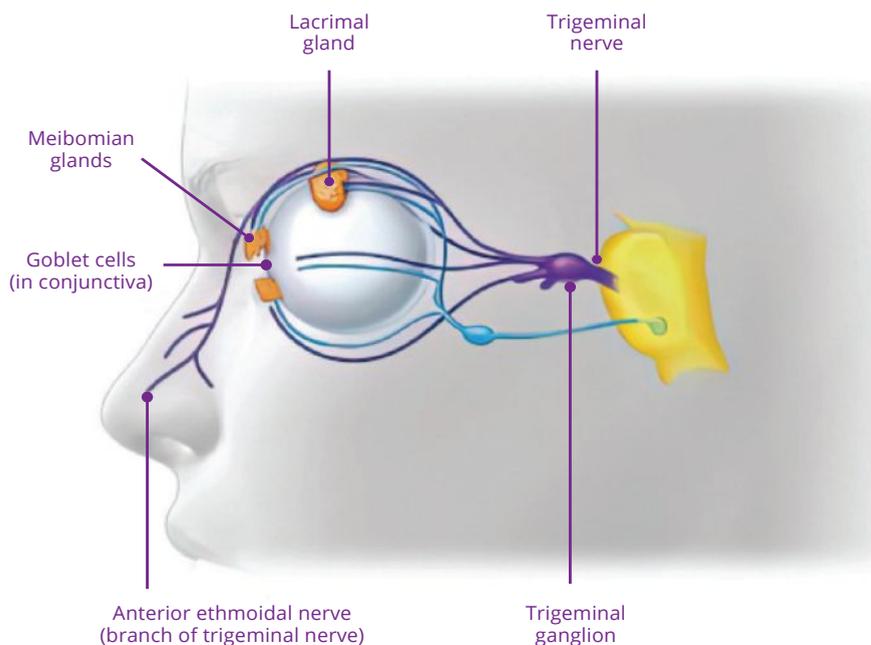
Real tears, including basal tears, contain a complex milieu of over 2000 different components, each of which contribute to tear film stability and function.<sup>4-6</sup> This is just an example of some of the many components found in the tear film and their possible function.



**With over 2000 components within a healthy human tear, treatment of dry eye should take into consideration the production of healthy, real tears.**

Francis Mah, MD

The tear film and its many components are created and cleared by the lacrimal functional unit (LFU), which consists of the main and accessory lacrimal glands, meibomian glands, conjunctival goblet cells, and the lacrimal drainage system that is interconnected by sensory and motor nerves. The nerves of the LFU connect it to the central nervous system (CNS) via the trigeminal nerve and the trigeminal ganglion. Stimuli from either the ocular surface or the nose are transduced through the trigeminal nerve to the CNS (the afferent pathway) and then transmitted via efferent pathways to the secretory tissues (eg, main and accessory lacrimal glands, conjunctival goblet cells, and meibomian glands) and muscles that drive tear production and blinking (**Figure 3**). Stimulation of the LFU from intrinsic and extrinsic factors regulates tear production and helps produce a homeostatic tear.<sup>1,3</sup> For instance, normal, unlabored breathing and consistent airflow through the nasal passageways provide constant sensory stimuli to the LFU, which accounts for approximately 34% of basal tear production.<sup>13</sup>



**FIGURE 3:**

Tears are created and cleared by the lacrimal functional unit (LFU), which consists of the main and accessory lacrimal glands, meibomian glands, conjunctival goblet cells, and the lacrimal drainage system that is interconnected by sensory and motor nerves. The nerves of the LFU connect it to the central nervous system via the trigeminal nerve and the trigeminal ganglion.<sup>1,3</sup> In this illustration, the afferent pathway is shown in purple, the efferent pathway is shown in blue.

It is widely acknowledged that dry eye is a multifactorial disease with many different etiologies. However, regardless of the etiology, the main goal of dry eye management is to break the cycle of dry eye by restoring tear film homeostasis, which can prevent the disease from either recurring or increasing in severity.<sup>2,3</sup> Dry eye treatment plans often start with environmental and behavioral modifications to reduce potential triggers and the implementation of lid hygiene regimens, as well as the use of artificial tears.<sup>2</sup> Artificial tears are considered a cornerstone of dry eye treatment and are formulated to mimic or supplement the mucoaqueous and lipid layers of the tear film.<sup>2</sup> However, they do not contain the biologically active components found in real tears and are temporary, palliative treatments that do not directly address the underlying etiology of dry eye.<sup>2,14</sup>

Furthermore, patients may encounter certain problems when using an eyedrop like an artificial tear. Depending on their age and dexterity, some patients may not be able to get a drop into their eyes or may have difficulties squeezing the bottle and others may dispense too many drops at a time.<sup>15</sup> Many patients initially choose to self-treat with artificial tears and may incorrectly use them.<sup>16</sup> Also, because each drop is a larger volume than that of the real tear film, they may induce reflex tearing and blinking and wash away natural components found in the tear film.<sup>17</sup>



**Restoration of tear film homeostasis and disruption of the cycle of dry eye may be achieved by creating a real tear.**

Jessica Steen, OD, FAAO

Additionally, artificial tears may contain anti-microbial preservatives that have been shown to harm the ocular surface and further exacerbate the signs and symptoms of dry eye. Benzalkonium chloride (BAK) is one of the most common anti-microbial preservatives used in eye drops and evidence suggests that BAK adversely effects the ocular surface by being toxic to corneal and conjunctival cells, including conjunctival goblet cells and corneal nerves, and delaying corneal wound healing.<sup>2,18</sup>

If patients have tried artificial tears and continue to have dry eye signs or symptoms, they are likely to be switched to a prescription eye drop, either an anti-inflammatory or a lipid layer enhancer.<sup>2</sup> While these prescription drops have been shown to treat dry eye, they may also have their difficulties. For instance, these eye drops need to be administered either twice or four times a day and are not compatible with contact lenses; for each administration, the patient must remove their contact lenses and keep them out for up to 30 minutes after instilling the drop.<sup>19-24</sup> Other approaches such as devices (eg, intense pulsed light therapy), tea tree oil, punctal occlusion, or therapeutic contact lenses may be used depending on the type of dry eye present and its severity.<sup>2</sup>

Nasal neurostimulation provides an alternative approach for the treatment of dry eye as it does not require patients to instill eye drops. Since part of the LFU can be accessed via the nasal cavities, it can be stimulated to induce the lacrimal glands, meibomian glands, conjunctival goblet cells, and other components of the LFU to produce basal tears.<sup>1-3</sup> Unlike artificial tears that mimic specific components of the tear film, nasal neurostimulation is thought to induce the production of a real tear.<sup>13</sup>

If the goal of dry eye therapy is to break the cycle of dry eye, then one key mechanism to doing so may be to stimulate the creation of real tears and restore tear film stability.<sup>1-3</sup> While artificial tears are a step in the right direction, they offer temporary, symptomatic relief without addressing the underlying causes of dry eye.<sup>2,14</sup> The other common treatment option, anti-inflammatories, specifically targets inflammation, which is downstream of tear film stability and does not directly restore tear film homeostasis.<sup>2,9</sup> Therefore, treatment for dry eye should begin by adequately addressing tear film instability as a distinct process, thereby breaking the cycle of dry eye.

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BY PAUL M. KARPECKI, OD  
CHIEF CLINICAL EDITOR

## THROUGH MY EYES

# Corneal and Allergy Conundrums

*Let's dive into both worlds and explore new treatments.*

**C**orneal disease has always been a mainstay of optometry, and perhaps the reason we love it is that all the answers are right in front of you. There is no need for added lenses, widefield imaging and other advances. Let's look at when to refer, as well as revisit new developments in allergic conjunctivitis management.

## Infectious Keratitis

While it's well within our scope to manage microbial keratitis, there are a few cases that warrant a consultation with a cornea specialist. Furthermore, to accurately diagnose microbial keratitis, we need to clearly differentiate an infectious cause, where steroids should be avoided, and from a sterile cause, where steroids are required. I would go so far as to avoid not only steroid drops alone but also combination antibiotic/steroid drops in the following cornea cases where an infiltrate/ulcer is or has:

- Within the central 5mm to 6mm of the cornea.
- Diameter of 3mm or larger.
- Anterior chamber cell and/or flare or hypopyon.
- Significant pain and photophobia.
- Decreasing vision or vision loss.
- Discharge or significant debris/discharge in the tear film.

In the scenarios above, it is imperative that you see the patient back the next day, so begin with an antibiotic drop Q2h (and in-office cycloplegia) if in doubt. The diagnosis usually becomes easier

a day later. Many of the above criteria may also require culturing and possibly a cornea specialist referral.

Speaking of referrals, the best time to send a patient with Fuchs' dystrophy to a specialist for a potential Descemet's membrane endothelial keratoplasty/Descemet's stripping endothelial keratoplasty is if central guttae are present and:

- Pachymetry is 600µm to 640µm.
- There is morning blur for one to two hours before it begins to clear.
- Specular microscopy CellChek SL (Konan Medical) shows an endothelial cell density of less than 1000 cells/mm<sup>2</sup>.

“**While it's well within our scope to manage microbial keratitis, there are a few cases where a consult with a cornea specialist is warranted.**”

## New Allergy Treatments

Here in Kentucky, pollen counts soar and patients with dry eye flares flood the clinic. Be sure to educate them on the use of corticosteroids like loteprednol 0.2% (Alrex, Bausch + Lomb) loteprednol 0.25% (Eysuvis, Alcon) or fluorometholone 0.1% (Flarex, Harrow) as being essential and, frankly, it's the only class of drugs that can quiet a dry eye flare.

Rinsada is a lid retractor/irrigation system that removes ocular surface biofilm and irritants such as allergens. It delivers irrigation to the conjunctival fornix,

palpebral conjunctiva and the bulbar conjunctiva simultaneously. Although it is primarily used for removing biofilm in the upper, patients get relief especially during the allergy season.

Allergy cleanser wipes (OcuSoft Allergy) and preservative-free artificial tears can help remove pollen, but one eye drop in particular appears to be most effective for dry eye with allergic conjunctivitis—Allegro (Optase), known as Hylo Dual to our Canadian colleagues. Allegro is preservative- and phosphate-free, has been shown to reduce itchy dry eye symptoms in 30 seconds and is compatible with contact lenses.<sup>1</sup> It contains ectoin, which is a naturally occurring molecule produced by microorganisms that flourish in dry environments such as salt lakes and deserts. Ectoin creates a water-rich barrier against allergens combined with hydroxyethyl cellulose, which is known to stabilize mucins that are essential for moisture and foreign particulate removal.<sup>2-5</sup>

Corneal disorders ranging from infectious keratitis to neuropathic corneal pain or chronic ocular surface pain and allergic eye disease are frequent in an optometry practice. Differentiating the correct diagnosis and subsequent proper treatment is imperative to sparing vision loss and optimizing results. ■

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About  
Dr. Karpecki

**Dr. Karpecki** is the director of Cornea and External Disease for Kentucky Eye Institute and an associate professor at KYCO. He is the Chief Clinical Editor for Review of Optometry and chair of the New Technologies & Treatments conferences. A fixture in optometric clinical education, he consults for a wide array of ophthalmic clients, including ones discussed in this article. Dr. Karpecki's full disclosure list can be found in the online version of this article at [www.reviewofoptometry.com](http://www.reviewofoptometry.com).



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**Study design:** The phase 3 randomized trial vs glasses alone included 117 patients age 4-7 with unilateral amblyopia associated with anisometropia and/or strabismus. The trial evaluated Luminopia 1 hour/day, 6 days/week with full-time corrective refraction vs full-time corrective refraction alone. The primary endpoint was change in BCVA at 12 weeks.

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\*Change in amblyopic BCVA at 12 weeks was 1.81 lines with Luminopia vs 0.85 lines with glasses alone.

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# What's Your Plan?

*Make patients see better. It should be as simple as that.*

**G**raduation alarmingly looms just ahead for our young, almost official doctors of optometry, like how progressive adds become a nightmare to a 41-year-old. It can be terrifying.

Will graduation make life better? Will it teach more lessons in the first year than any optometry school or residency can teach? Yep. That's also very terrifying to admit.

The Doctor of Optometry degree is certainly a well-earned honor. When I went to Pennsylvania College of Optometry 100 years ago, we only had to learn one thing:

You can't hurt someone if you make them see better. Took me all four years to get that. (OK, and five years of practicing.) The rest of what I learned was way less important than that one thing.

I was licensed in West Virginia in 1979. Everyone wanted a West Virginia optometry license because we were the first state in the union to permit optometrists to treat medical conditions of the eye with eye drops. That's right, North Carolina! You heard me. There's no shame in being second.

Hundreds of young graduates flocked to West Virginia to take the state board examination. Florida even offered reciprocity. This was unheard of in those days and, of course, West Virginia turned them down because everyone knew that all the Florida optometrists living on the beach in paradise would immediately move up to the Mountain State and the 300 ODs already in West Virginia would be put out of business. (I know... that was stupid and it would probably have been

the other way around as the 300 ODs moved to retirement at the beach.)

Just try to get a Florida license now. I hear they require an MD degree to get an OD license or something. Probably just a rumor?

So, what's your plan, young optometrist? I used to believe that now you guys would have to put your cell phones down, missing the ceaseless wisdom of TikTok dances and you would have to see patients... *i.e.*, actual humans right there in front of you. The horror...

But will you?

First, you have to pass the State Board of Optometry and they will ask you questions about some new technologically advanced gadget that was just invented three months ago that apparently does something vaguely related to seeing said patient... *i.e.*, the actual human sitting right there in front of you. Then comes the ever-important chemical composition of some new medication that might be approved by the FDA someday. Then, their most important concern: Are you on mood-altering sub-

stances? For example, peanut butter cookies.

After that, you will still have to find a position unless mom or dad wants you in their hopelessly outdated practice in the worst part of town where you will have to convince them that, sure, that carpet was great in 1973, but...

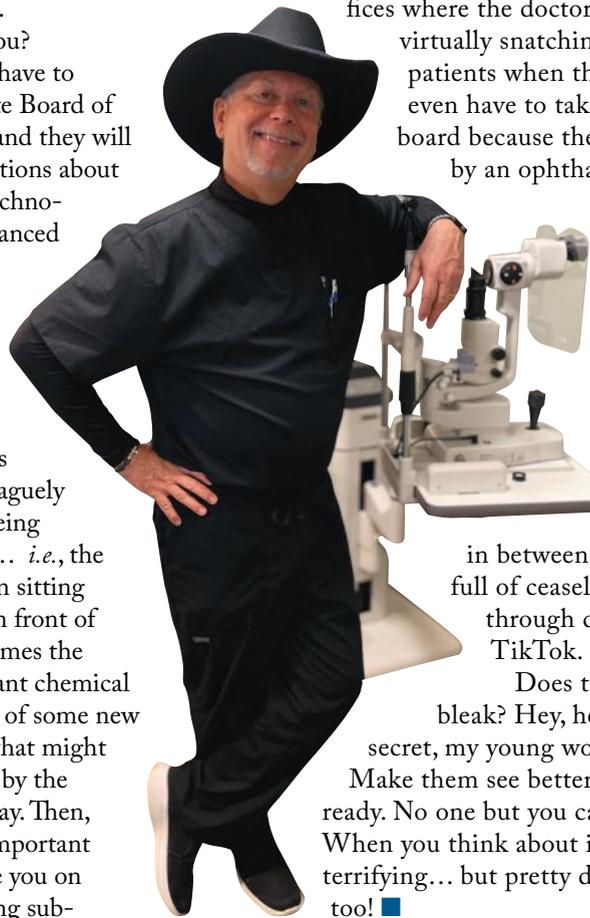
Now, you only compete with yourself. OK, that's a lie. You compete with the 42 million underpaying vision plans, not to mention the offices where the doctor is in Topeka

virtually snatching up your patients when they didn't even have to take your state board because they are owned by an ophthalmologist or

by one of the 42 million underpaying vision plans where they do eye examination on their cell phones

in between getting CE full of ceaseless wisdom through dances on TikTok.

Does this sound bleak? Hey, here's the secret, my young wonders: Make them see better. You are ready. No one but you can mess it up. When you think about it that is also terrifying... but pretty damn exciting, too! ■



**About Dr. Vickers**

**Dr. Vickers** received his optometry degree from the Pennsylvania College of Optometry in 1979 and was clinical director at Vision Associates in St. Albans, WV, for 36 years. He is now in private practice in Dallas, where he continues to practice full-scope optometry. He has no financial interests to disclose.

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\*Prescription market data, Dec. 2022 – S01K without cyclosporine.

<sup>1</sup>In a chronic dry eye patient usage study, participants from a variety of socioeconomic backgrounds answered questions about their experience with iVIZIA lubricant drops. In the study, 203 chronic dry eye patients, 28-80 years old, switched from their dry eye artificial tears to iVIZIA for a month.<sup>1</sup>

<sup>‡</sup>To limit blurriness when using contact lenses, remove contacts, apply drops, then insert contacts.

Reference: 1. Thea Data on File.

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BY JEROME SHERMAN, OD, AND SHERRY BASS, OD

## YOU BE THE JUDGE

# Flashes? Think Beyond the Retina

*Limiting your exam of a patient who presents with this complaint can prove to be disastrous.*

**A**lthough light flashes are a common symptom of vitreal-retinal traction, we must consider other etiologies such as prodrome to migraine as well. Persistent flashes in the absence of evidence of these two common causes should alert the clinician to search for other etiologies. Just as traction of the vitreous on the retina often produces light flashes, compression of any component of the visual pathway by a mass lesion can also result in light flashes. Reliance on confrontation visual fields to rule out visual pathway disorders may have a catastrophic outcome (such as discussed previously in our November 2023 column).

## Case

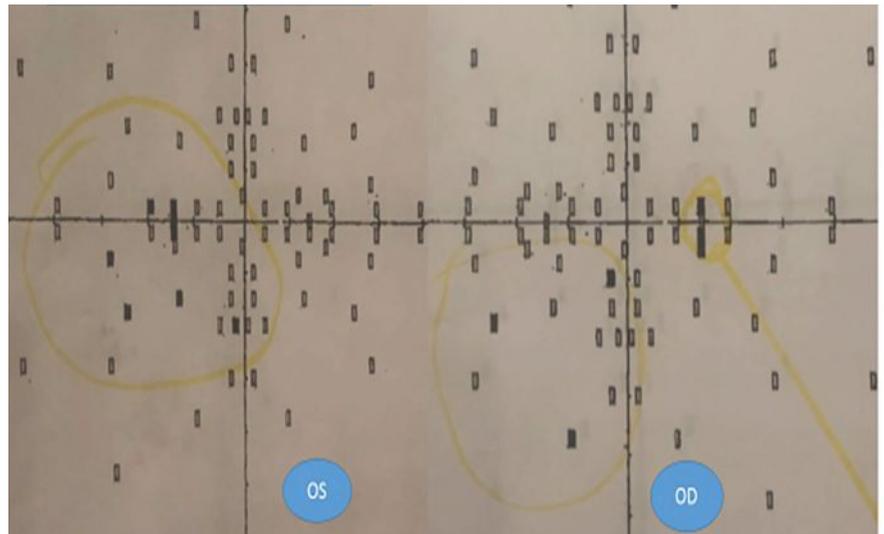
A 15-year-old girl presented with a complaint of headaches and flashing lights. Best-corrected visual acuity (BCVA) was recorded as 20/20 OD and 20/20 OS. The external examination elements, including pupils, motility and confrontation visual fields (VFs), were recorded as normal, as was a dilated fundus exam (DFE). Because of the symptoms of headaches and flashing lights, a visual field screening was performed. The results were labeled as “marginal/questionable” (*Figure 1*). The eye clinician recommended a follow-up exam in one year.

The patient returned one year later, still complaining of headaches and flashing lights. She also complained of occasional problems focusing. VA was 20/20 OU with  $-0.25$  sphere in each eye. The external exam, including motility, pupils and confrontation VFs, was recorded as normal. The diagnosis was myopia and paresis of accommodation. Again, a follow-up exam was recommended in one year. At age 17, the patient presented still complaining of headaches and flashing lights. BCVA was still 20/20 in each eye with  $-0.25$  sphere in each eye. The DFE was recorded as normal, including disc margins and periphery.

Her diagnosis remained unchanged, and the patient was told once again to return in one year.

One year later, headaches and flashing lights as the chief complaints were again recorded. VA was still correctable to 20/20 with a  $-0.25$  sphere in each eye. Once again, the external exam, including pupils, motility and VFs, were recorded as normal. The fundus exam noted normal disc margins and periphery in each eye. It was recommended that the patient return again in one year.

Nine months after the eye exam at age 18, the patient presented with family members to the emergency room (ER) of a major hospital. The initial diagnosis was “altered mental status, severe drowsiness and acute blindness.” An MRI that was ordered revealed a giant parietal-occipital meningioma  $8 \times 8 \times 7$  cm, primarily on the right side of the midline (*Figure 2*). A craniotomy and resection in a nine-hour operation was performed the next day. This first procedure removed 95% of the mass, and a shunt and gamma knife



**Fig. 1.** VF screening on first visit. Yellow circles drawn years after exam.

About Drs.  
Sherman  
and Bass

**Dr. Sherman** is a Distinguished Teaching Professor at the SUNY State College of Optometry and editor-in-chief of *Retina Revealed* at [www.retinarevealed.com](http://www.retinarevealed.com). During his 53 years at SUNY, Dr. Sherman has published about 750 various manuscripts. He has also served as an expert witness in 400 malpractice cases, approximately equally split between plaintiff and defendant. Dr. Sherman has received support for *Retina Revealed* from Carl Zeiss Meditec, MacuHealth and Konan. **Dr. Bass** is a Distinguished Teaching Professor at the SUNY College of Optometry and is an attending in the Retina Clinic of the University Eye Center. She has served as an expert witness in a significant number of malpractice cases, the majority in support of the defendant. She serves as a consultant for ProQR Therapeutics.

radiation were performed later for the remaining 5%. There has been no regrowth of the meningioma to date.

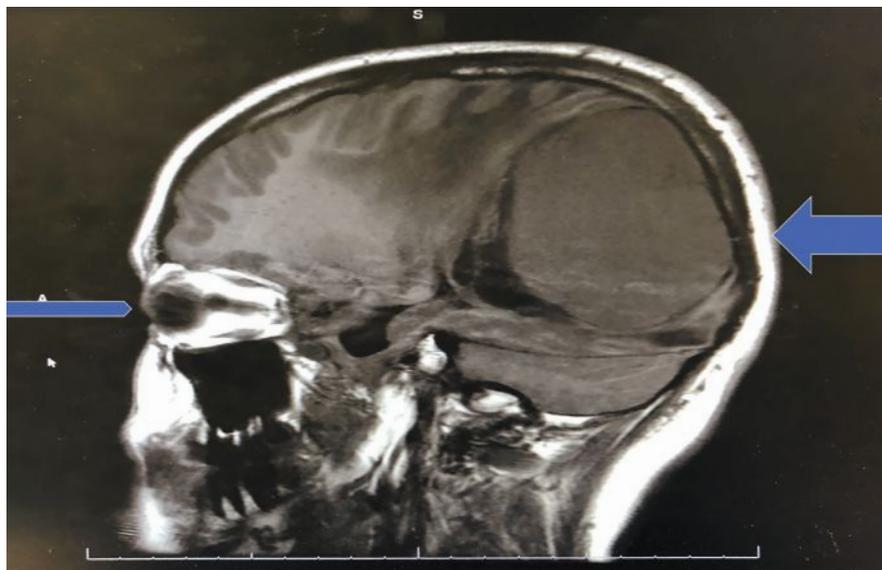
After the multiple procedures to remove the giant meningioma, which expanded to occupy about a third of the cranium, the patient had some remaining central vision in the right eye and finger-counting VA in the left eye. The patient was now in her early 20s, and her fields were very constricted, with no hope of her vision ever recovering. An OCT revealed virtually no remaining retinal nerve fiber layer in either eye. The patient learned to use a cane and relies on a seeing eye dog.

The eye clinician who examined the patient for four consecutive years as a teenager, as well as her pediatrician and an ear, nose and throat (ENT) specialist, were all sued for failure to appropriately evaluate the patient. The pediatrician referred the patient once to ENT for a complaint of hearing difficulty in her right ear, but neither physician ordered a CT or MRI.

### You Be the Judge

In light of the facts presented thus far, consider the following questions:

- On the field screening performed at the first visit, were there findings suggestive of a problem affecting the visual pathways?
- Should the field screening on the first visit that was labeled as “marginal/questionable” have been repeated on subsequent visits?
- Is an MRI considered the standard of care for a patient complaining of headaches and flashing lights?
- Are confrontation VFs, recorded as being performed and normal on each of the four yearly visits, the standard of care?
- Do you believe that confrontation VFs were performed and were normal nine months prior to the ER visit, which revealed a meningioma occupying about a third of the cranium?
- Is the eye clinician culpable of malpractice?
- Could artificial intelligence (AI) have prevented the disastrous outcome?



**Fig. 2.** This sagittal MRI images both the right eye and the parietal-occipital mass. Note the size of the mass relative to the size of the globe.

### Diametrically Opposed Opinions

One of us (JS) was requested to review all the available records and opine whether the eye clinician met the existing standard of care on each of the four visits.

On the first visit, at age 15, the records noted that a VF screening was performed because of the chief complaints of headaches and flashing lights. Although the field screening was labeled as “marginal/questionable,” a careful review of the fields would reveal four missed points in the inferotemporal quadrant of the left eye and three missed points in the inferonasal quadrant of the right eye. This suggestive homonymous quadrantanopsia may be due to a post-chiasmal mass, affecting the superior optic radiations on the right side of the brain. The comment that the field results were “marginal/questionable” and not recognizing that the missed points were in corresponding quadrants is arguably not a violation of the standard of care. A like practitioner under like circumstances would, more likely than not, overlook this very subtle finding.

When the patient returned a year later still complaining of headaches and light flashes, the eye clinician relied on confrontation fields and did not repeat

the automated visual field, even though on the first visit the doctor noted that the fields were performed because of the complaints of headaches and flashing lights. This is arguably a violation of the standard of care since automated VFs are non-invasive and can be obtained in several minutes. Similarly, when the patient returned at age 17 with the same complaints, the doctor again relied on confrontation VFs and did not perform automated perimetry.

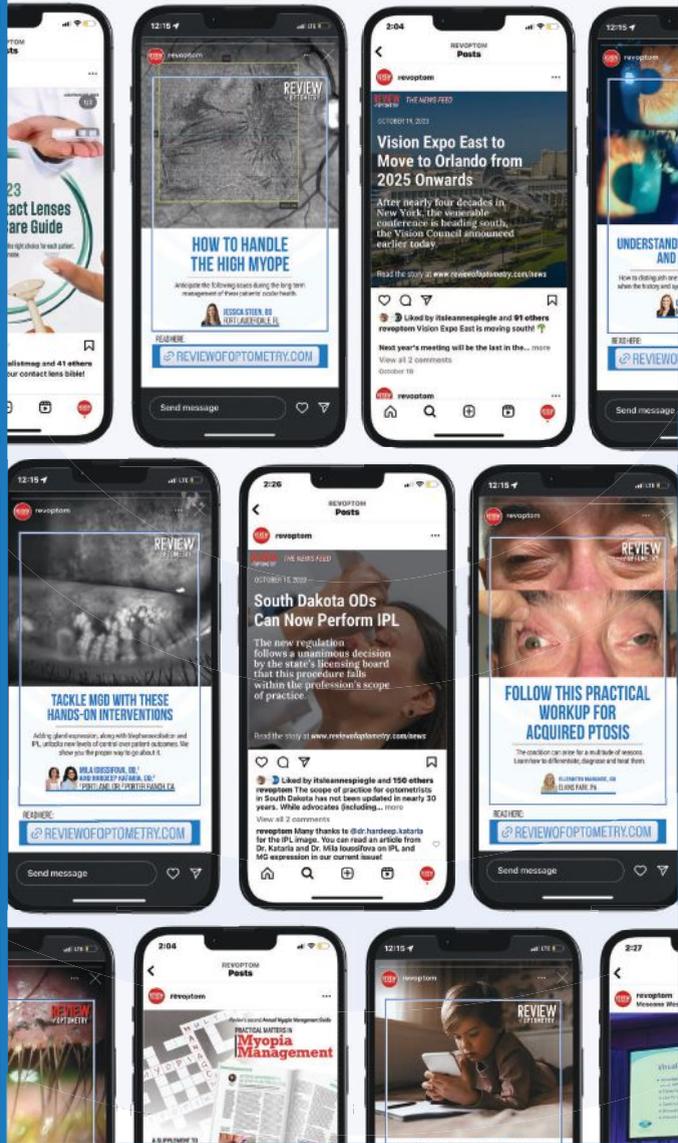
The last exam performed by the eye clinician took place a year later, when the patient was 18, and the record revealed that the patient was still complaining of headaches and flashing lights. Details of the headaches and flashing lights were never recorded on any of the visits. For the fourth time, the retina was noted as normal, including evaluation of the optic nerve heads and the peripheral retina in both eyes. This was the third consecutive visit when automated VFs were not performed, even though automated VF screening was performed on the first visit because of the complaint of headaches and flashing lights.

And then nine months later, the patient was rushed to the ER by family members and was diagnosed as having altered mental status, severe drowsiness

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## YOU BE THE JUDGE | Flashes? Think Beyond the Retina

and acute blindness. The MRI revealed a giant parietal-occipital meningioma. Bear in mind that meningiomas are nearly always slow-growing, strongly supporting the opinion that the tumor was present and slowly increasing in size over many years. Could confrontation fields have been normal nine months earlier? An underappreciated advantage of automated VFs is that it furnishes proof that fields were performed on a specific patient on a specific date.

There is no way to prove that confrontation VFs were performed and performed appropriately; most clinicians would conclude in such a case that either confrontation VFs were not performed or not performed appropriately. Unlike automated VFs, confrontation VFs can be influenced by human factors such as hunger, thirst, incoming text messages, number of patients in the waiting room, complaining about waiting time, etc.

The two experts who defended the eye clinician argued that many teenagers were incapable of performing automated VFs and that confrontation VFs are adequate to meet the standard of care and to detect large brain tumors. To quote these experts: “Automated visual fields in patients under the age of 18 are often notoriously unreliable.” In contrast, most eye clinicians will argue that teenagers, because of spending hundreds of hours playing video games, are far better than our typical, elderly glaucoma patients at performing meaningful VFs. One of these experts noted “confrontation visual fields when done appropriately with special techniques can be highly reliable.”

In this case, there is no evidence that any “special techniques” were ever incorporated in the confrontation visual fields. The two experts also opined that there was no substantial evidence on the four visits that neuroimaging was required since a mere complaint of headaches—a very common symptom—does not require a CT or MRI. This is arguable but a noninvasive, rapid and inexpensive and available procedure such as automated VFs clearly was indicated.

When a visual field device that incorporates AI reaches the market, consider it, since AI will easily recognize such a subtle homonymous quadrantanopia and other retinal, optic nerve and visual pathway patterns.

The case was settled prior to a jury trial for several million dollars.

## Takeaways

There were many lessons learned from this case, such as:

- When VFs are marginal or questionable, repeat them!
- Even in these uncertain VFs, there may be a pattern suggestive of a visual pathway abnormality: Look for it!
- “Normal” confrontation VFs give the patient and doctor a false sense of security.
- Don’t ignore symptoms and complaints that patients have repeated.
- When a patient consistently complains of headaches and flashing lights, think brain tumor!<sup>1</sup> ■

1. Botterell EH. Early recognition of brain tumors. *Postgrad Med.* 1964. 36(4):297-300.



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# BUILDING A TOP-FLIGHT STAFF

A successful optometry practice requires a dedicated, passionate team and effective leadership. Here's how to land ideal candidates and foster a positive office environment to keep them there long-term.

BY CATLIN NALLEY  
CONTRIBUTING EDITOR

A successful optometric practice depends not only on clinical expertise and innovation but also every member of the care team—from front desk staff and opticians to technicians and optometrists. A top-flight staff ensures positive patient experiences and drives sustainable growth. However, finding and retaining quality individuals presents unique challenges.

In this article, we delve into the strategies and best practices essential for cultivating an outstanding optometric team. From the initial recruitment process to ongoing growth and retention efforts, seasoned optometrists offer advice on the intricacies of building a strong workforce.

## Culture and Mindset

While every practice owner may approach staff recruitment and retention in their own way, a positive workplace culture is paramount for long-term success.

“Cultivating a strong team starts with the leader’s individual self work and mindset,” says Katie Davis, OD, owner of the Vision Therapy Institute in Columbia, SC. “The more work I’ve done on my mindset, gratitude practices and how I operate in the world, the more

I’ve been able to create an environment where people want to stay and work with me to build something beyond the job,” she says.

Dr. Davis acknowledges that this approach is not an easy one; however, in the long run, focusing on the culture of an organization and creating a place where everyone wants to come to work is beneficial not only for the staff but also for the success of your practice as a whole.

The foundation of a positive workplace culture is gratitude and appreciation, she emphasizes. “Paying your staff well—while important—isn’t always enough. Our teams want to feel appreciated, and that may look different for each individual.”

At Dr. Davis’ practice, every new hire packet includes a book by Gary Chapman and Paul White, titled *The 5 Languages of Appreciation in the Workplace*, which helps her show appreciation to team members in the manner that means the most to them as individuals.

Fostering a culture of appreciation and

growth goes hand-in-hand with successful staff recruitment and retention. “At our practice, we approach everything with a growth mindset,” explains Dr. Davis. “While a fixed mindset is one where you believe talent and intelligence are something individuals either have or don’t have, a growth mindset views talent, skills and intelligence as qualities that can be developed.”

When challenges do arise, it is important to frame any conflict or problem from a solution-based perspective, advises Dr. Davis. “Instead of saying this staff member did this, we ask the question, ‘What system did we not have in place to support you or this situation?’”



Photo: Getty Images

**Cultivating a positive workplace environment involves understanding each member of your team and making them feel appreciated.**

This doesn't happen overnight; however, with the right tools, you can build a culture of support. "If someone has a complaint, they are expected to bring a potential solution," says Dr. Davis. "We emphasize outcomes not an individual mistake and work together to resolve any issues."

### Attracting Your Ideal Team

When beginning recruitment, it is critical to align your efforts with the core values and culture of your practice. By doing so, you will find it easier to attract team members that share your vision and values.

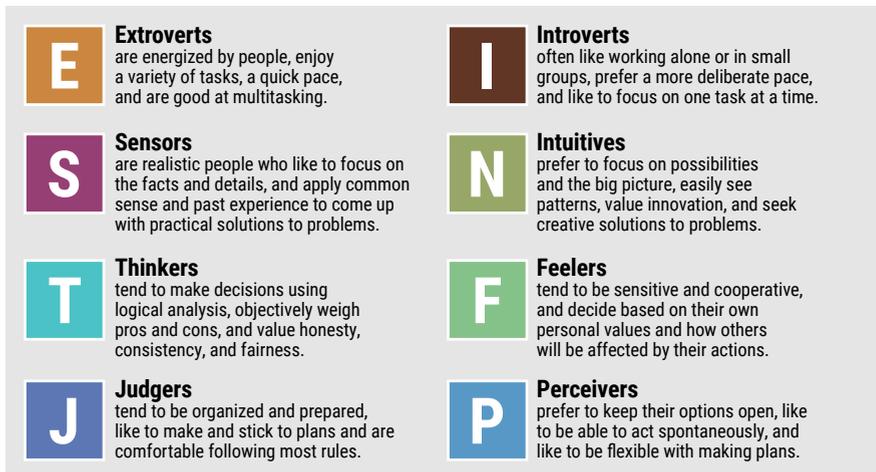
For Susan Keene, OD, who owns Envision Eye Care in Marion, VA, finding the right people depends on a thorough interview process. "We start with a phone interview," she says. "This includes a discussion of our core values to give the individual a better understanding of what we are looking for and if it might be a good fit."

Next comes the in-person interview and, if time permits, a brief period of job-shadowing to give them a glimpse of the practice and the role they are applying for, she explains. Lastly, interviewees will take the Myers-Briggs (*Figure 1*) or DiSC personality assessments.

"While I do feel like we get it right more often than not, there will always be occasional cases where someone is a great interviewer yet not a great fit," notes Dr. Keene. "Today, if you are going to have success in hiring, you need to take a thoughtful approach and always keep your core values at the forefront of the process."

Ted McElroy, OD, owner and optometrist at Vision Source Tifton in Tifton, GA, emphasizes the importance of vetting potential team members in the right way. At his practice, the interview process includes more than one perspective—Dr. McElroy, the operations administrator and a team member from the area with the open position.

The first question Dr. McElroy and his team always like to ask is, "Did you have any trouble finding the place?" This is a good way to find out which candi-



**Fig. 1. Dr. Keene uses the Myers-Briggs personality test (results key shown here) or the DiSC personality assessment when interviewing prospective employees for her practice to get a better sense of how they might fit into her team.**

dates took the time to plan ahead and make sure they knew where they were going prior to the interview.

"We also ask a number of behavioral-based questions," he says. "For example, 'Tell me about a time you had a challenge with a coworker.'" Questions like this help you understand how an individual approaches difficult situations. Are they proactive? Do they know how to problem solve?

Their hiring process also includes a working interview (the interviewees are compensated for their time). "This is one of the most beneficial things we do," notes Dr. McElroy. "Not only do we have the opportunity to observe potential staff members in a work environment, but they also have the chance to experience our practice and how it operates."

Where do you find individuals that align with your company culture? Dr. Davis recommends an active recruiting approach. "Look for individuals in the community whose personality could be a good fit for your practice," she says. "You can teach individuals new skills, but finding people with the right personality or mindset can be more of a challenge."

Oftentimes, current team members are the best resource. "When a position becomes available, it is very rare that we have to go out and find someone,"

says Dr. Davis. "Our staff is our greatest source for high-level people."

Dr. McElroy takes a similar approach. "Identify your A-players and ask them for recommendations first," he suggests. "The type of people you want working with you are already at your practice, and often they will know other individuals who could add value to your team."

### Fostering Staff Longevity

Finding and training new team members requires a significant investment of time and money; therefore, dedicating resources for employee retention is equally important to ensure the overall success of the practice.

There are a number of ways to incentivize staff members to stay long-term, including salary, PTO and other benefits. Dr. McElroy offers a flexible PTO program that gives his team more control over their time off. "We don't classify our PTO as sick or vacation time," he says. "They can take their PTO as needed. We allow them to use smaller blocks of time to take off an hour here or two hours there, which gives them more flexibility to use their PTO in a way that best fits their individual needs."

Additionally, Dr. McElroy does not allow his team to carry over PTO year to year. "I want them to use their PTO because everyone needs time away from

work to decompress,” he explains. “In the past, I have found that individuals who do not take time off are more likely to burnout, and that isn’t good for them or the practice.”

While important, maintaining high employee retention rates takes more than the standard incentives. A key component of the longevity Dr. McElroy has seen with his team is engagement. “Leaders must connect with their team,” he urges. “What I have found is that the practices that are most successful are the ones that actively engage and the ones that are least successful are doing everything they can to avoid their team.”

This doesn’t just mean being available when needed, but rather proactively scheduling time with your team. Dr. McElroy sets aside time every Friday afternoon to have a one-on-one discussion with different members of his staff. “One of my favorite questions is, ‘What’s on your mind?’ and then I just sit there, shut up and let them start talking. Often this time becomes a coaching session, not just for them but also for me.”

Dr. McElroy takes this time to gain insight on the practice and his own leadership as well. Some questions he might ask include: If there’s something that I could do to make your job easier what would it be? What situations do you see where I am not communicating well with the rest of the team? If you were the leader of this organization, what would you fix first?

“They’ll come up with things that you never would have thought of because they’re seeing things from a completely different viewpoint than you do,” he says. “However, these conversations can’t take place unless you’re actually being vulnerable and sharing that you have bad days too where you might struggle or have challenges. If you’re not going to engage with your team, you’re going to lose them.”

To better connect with her staff, Dr. Keene has team meetings where every staff member takes an active role. “We have tried to create a culture of regular meetings and I do very little of the talking during that time,” she says, while noting that the team meetings are structured around the key performance indicators (KPIs) that drive revenue and production.

“Every week, different staff members from each location will own a KPI, and they are responsible for measuring and reporting those numbers to the rest of the team,” she explains.

As with any business, optometric practices have financial objectives, but the team may not always have a clear picture of the specific reasons behind these goals. “I may know that I have plans to remodel or purchase new

equipment, but I found that could come across as, ‘She just wants more money,’” says Dr. Keene.

When she started breaking down these goals and including her team, not only did revenue increase, but her staff felt more engaged and had the opportunity to see firsthand the impact they have on the success of the practice, their colleagues and the patients they serve.

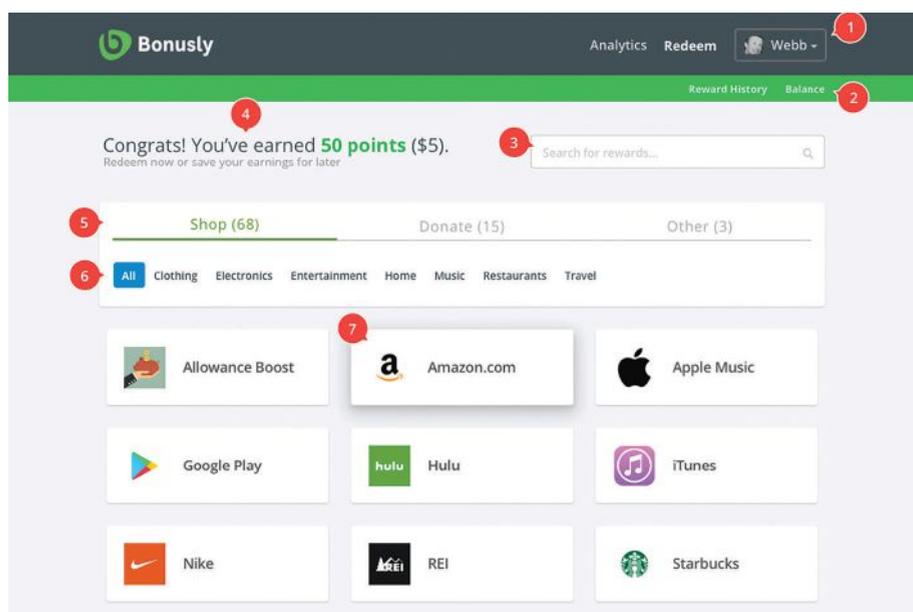
Dr. Keene has also observed that today’s employees are much more motivated by recognition, especially peer-to-peer acknowledgment. Her team recently started using an employee recognition tool (Bonusly; *Figure 2*). “At the beginning of each month, every staff member is given an allowance of 200 eyeglasses, which equates to money or gift cards,” she says.

“Throughout the month, they can give their colleagues eyeglasses when someone does something that embodies one of our core values. For example, one employee might give their coworker five eyeglasses because they took the time to help them learn how to use a piece of equipment that they were struggling to master.”

Recognizing your employees for their own work as well as for what they do to support one another fosters an environment where they are not just happy to do their job, but they are incentivized to go above and beyond expectations.

Investing in training and development will also help maintain a healthy culture where team members are happy, and the practice is thriving. “Training your employees from day one is critical for their success and the success of your practice,” says Dr. Keene.

“We have developed training programs that are multilevel, so that our team members can continue to grow and enhance their skills. While some employees are happy where they are,



**Fig. 2.** One tool to incentivize staff to perform at their best is Bonusly, which Dr. Keene uses at her practice. Through the website, employees receive a monthly allowance, redeemable for money or gift cards, which they can share with their peers when, for example, a staff member goes above and beyond for a patient.

Photo: Bonusly

others want to grow within the organization, and we want to make sure they have the opportunity to do so.”

Dr. McElroy will also encourage his team to take part in leadership courses and other educational opportunities. By supporting employees, even if they one day outgrow your practice, it is beneficial for everyone involved, and they are more likely to go the extra mile.

Make it clear to your team that you are dedicated to helping them grow within your practice and beyond. “What kind of individual could you be if you help your staff find what that next part of their life is going to be like? How hard do you think they would work to try and find somebody to replace themselves? This has happened in my own practice,” he says. “Everyone benefits when your team members have the opportunity to succeed.”

Optometrists who own their practices have control over incentives and creative solutions like the ones discussed above, but what about the optometrist employed at a chain or private equity owned practice who may have less leverage when it comes to decision-making?

While this scenario may not allow for the same degree of freedom and control, optometrists working in this environment can still have an impact on company culture as well as staff recruitment and retention efforts. “Be proactive and communicate with the owner,” suggests Dr. Keene, while emphasizing the importance of being on the same page.

Once the OD has a clear understanding of the owner’s specific goals for the practice, they can offer their own insights and support. For example, the goal is to increase optical sales. The OD might encourage the owner to create an incentive for employees. This doesn’t always have to be monetary. It could be as simple as a dinner at the end of the month if the goal is met, says Dr. Keene. These “mini games,” she notes, can be a fun way to encourage employees and build morale.

“It is hard if you’re not the owner; it truly is,” she notes. “But, even if you work for someone else, share your ideas and do what you can to work together for the success of the practice and its staff.”

## Takeaways

Effectively recruiting and retaining staff is a crucial component of the success of any optometric practice. Building a team of dedicated professionals is essential for the delivery of high-quality patient experiences and care.

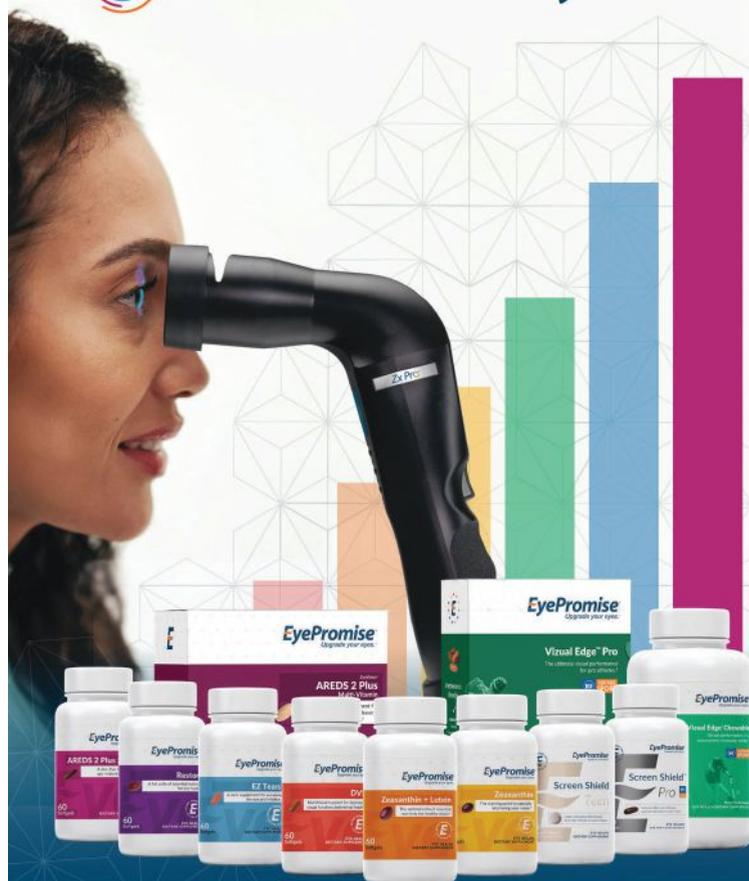
Attracting and keeping quality team members depends not only on competitive compensation and benefits but also on a positive workplace culture where staff members feel appreciated and have the opportunity to grow and take ownership of their contributions.

Navigating the complexities of personnel management is not one-size-fits-all and requires a dedicated leader that recognizes the power of a strong staff and is willing to do their part to help every member succeed—both as an individual and as a team. ■

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# SIZING UP KERATOCONUS: THE ROLES OF TOPOGRAPHY AND TOMOGRAPHY

Three different imaging modalities serve their own purposes for diagnosing and monitoring this condition.



BY JULIE SONG, OD  
NEW YORK CITY

If you are like me and regularly find yourself evaluating topographical maps, you have probably had a variety of thoughts. When starting out in an academic setting, you might have asked yourself: What do these values mean? Which numbers should I pay the most attention to? How do I diagnose conditions based on these maps? Which patients need to have a scan performed on their corneas? Eventually in practice, you may be wondering: Which instrument is worth the money? Which data is reliable, and which is misleading? Now that I have the basics, where can I take this data further in my patient care?

This article will answer questions that help distinguish how to best use these devices or read the data.

## Instrumentation

In a market where there are so many different options to evaluate data, it can

be difficult to discern which options are truly necessary and where clinical data can become misleading. It is important to differentiate between corneal topography and corneal tomography scans. Corneal topography and corneal tomography serve as crucial diagnostic tools, and each offer distinct insights into the structure of the cornea. More commonly, you will likely encounter corneal topography instruments in your average practice setting due to its accessibility and lower cost. Corneal topography focuses on the anterior surface, providing a detailed two-dimensional map of its curvature and identifying irregularities such as corneal astigmatism. This method is valuable for assessing refractive errors and aiding in the planning of corrective procedures.

In contrast, corneal tomography goes beyond surface analysis, offering a comprehensive three-dimensional representation of the entire cornea. This includes details about corneal thickness and the posterior surface, making it particularly useful for detecting conditions such as subtle keratoconus

and other corneal ectasias. Corneal tomography provides a holistic assessment of corneal structure and aids in early detection of pathological changes that corneal topography instrumentation may not provide. Therefore, while corneal topography excels in surface analysis, corneal tomography offers a three-dimensional perspective vital for a thorough evaluation of the cornea's structure.

There are three main types of imaging devices used to perform corneal topography and corneal tomography scans: Placido disc devices, Scheimpflug imaging and anterior segment OCT (AS-OCT). While the latter reveals what type of corneal scan it can produce based on the name itself, it is important to delve into each one of these machines to understand how they capture information and to determine which one makes the most sense for your practice setting needs.

## Placido Ring Corneal Topography

These corneal instruments are widely used for corneal topography and not

### About the author

Dr. Song earned her degree from the SUNY College of Optometry and stayed on to complete her residency in cornea and contact lenses with an emphasis in anterior segment and ocular disease. She graduated with the honors of the Chancellor's Award for Student Excellence and the Johnson & Johnson Vision Award of Excellence in Contact Lens Patient Care. Upon residency completion, she became a fellow of the American Academy of Optometry and was the inaugural winner of the Visionary in Eye Care Resident Recognition Award in the "Best in Optometry" category. She currently serves on the GP Lens Institute Rising Stars Committee and is a participant in the American Optometric Association Leadership Institute. Dr. Song has delivered numerous COPE-approved lectures and presented many posters at academic meetings. She currently works at Fromer Eye Centers seeing specialty contact lens patients.

calculate contact lens parameters and more.<sup>1</sup> These devices are even capable of performing dry eye assessments due to the noninvasive keratography dry-up time that can be measured because of the device's dependence on tear film.<sup>2</sup>

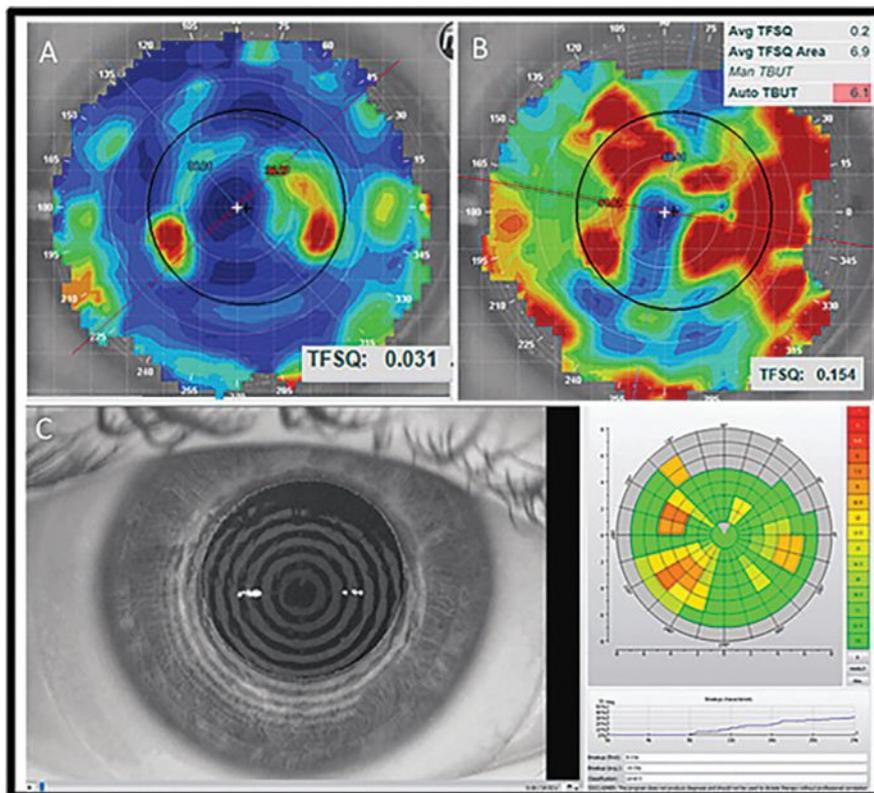
While Placido ring corneal topography remains a valuable tool in practice, it has some limitations and disadvantages. First and foremost, the Placido ring instrument does not provide posterior surface information since it focuses on the anterior surface of the cornea.<sup>1</sup> This limitation may be incredibly significant in conditions where abnormalities or changes occur in the posterior cornea.

Second, the accuracy of Placido ring corneal topography is dependent on the quality of the tear film on the cornea. Tear film irregularities, such as dry spots or debris, may lead to distorted measurements, which impacts corneal map reliability.

Third, Placido ring technology can tend to struggle with cases of highly irregular corneas in providing accurate and detailed maps. The distortion of the ring pattern on severely irregular corneas can make it challenging to obtain precise measurements.

Fourth, this type of corneal topography does not provide information on corneal thickness. For conditions like keratoconus and glaucoma, where measuring pachymetry is crucial, an alternative instrument is needed to provide the patient treatment and management data. While the technology remains widely used and effective, eyecare professionals need to know these limitations in order to consider complementary diagnostic methods with specific corneal conditions or irregularities.

Overall, Placido ring corneal instruments play a vital role in modern ophthalmic practice by offering valuable insights into corneal structure and aiding in the diagnosis and treatment planning for a variety of eye conditions. More sophisticated Placido ring devices are now being combined with Scheimpflug imaging or scanning-slit technology to improve the relevance and use when imaging the cornea.<sup>3</sup>



**Fig. 1.** The top panel shows the tear film quality score display from an E300. The bottom panel is a similar assessment using the keratograph.

tomography assessments. These devices use a specific optical technique based on the principles of the Placido disc, named after Antonio Placido, who first described using a circular target with alternating concentric dark and light rings with a central aperture to photograph and observe the corneal reflections they produced in 1880.<sup>1</sup>

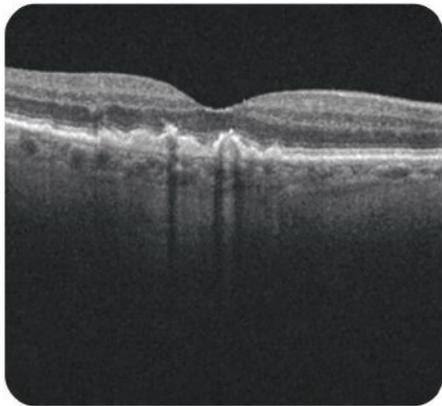
The Placido disc that we use today still consists of a series of concentric rings or circles that are illuminated and reflected off the cornea. As the rings are projected onto the cornea's surface, they create a distinct pattern of bright and dark areas. The instrument's camera captures this pattern and analyzes the reflected image to derive information about corneal shape and curvature.<sup>1</sup>

The measurement of corneal topography with Placido ring instruments relies on the distortion of the reflected ring pattern on the cornea. When the cornea is smooth and regular, the reflected rings are also smooth and symmetric. However, irregularities or abnormalities

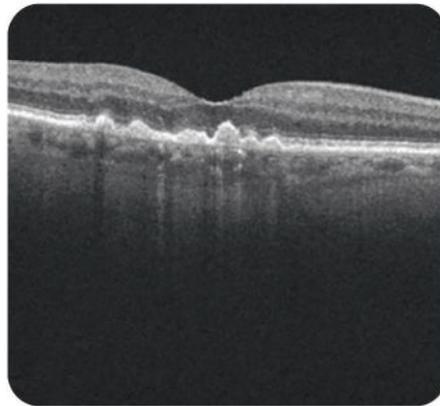
of the corneal surface cause distortions in the ring pattern. By assessing these distortions, the instrument can create a detailed map of the corneal surface and highlight areas of curvature variation and abnormalities.

One notable advantage of Placido ring corneal instruments is their noninvasive nature and efficiency in providing quick and accurate corneal topography measurements. Additionally, these instruments have been integral in enhancing the precision of refractive surgeries, as they allow eyecare professionals to tailor treatments based on the individualized corneal characteristics revealed by the topography maps. Practitioners can obtain pre-surgery assessments, customize ablation profiles and follow up post-surgically. For practitioners who prescribe specialty contact lenses, especially for gas permeable contact lenses such as orthokeratology, this device's advancements have allowed different contact lens fitting software programs to screen simulated fluorescein patterns,

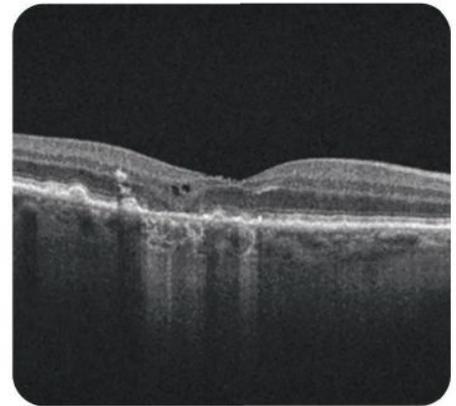
# GEOGRAPHIC ATROPHY (GA) CAN PROGRESS FASTER THAN YOU THINK<sup>1</sup>



**Baseline**



**Month 3**



**Month 6**

1. Boyer D, Schmidt-Erfurth U, van Lookeren Campagne M, et al. The pathophysiology of geographic atrophy secondary to age-related macular degeneration and the complement pathway as a therapeutic target. *Retina*. 2017;37(5);819-835.

## INDICATION

IZERVAY™ (avacincaptad pegol intravitreal solution) is indicated for the treatment of geographic atrophy (GA) secondary to age-related macular degeneration (AMD)

## IMPORTANT SAFETY INFORMATION

### CONTRAINDICATIONS

IZERVAY is contraindicated in patients with ocular or periocular infections and in patients with active intraocular inflammation.

### WARNINGS AND PRECAUTIONS

#### Endophthalmitis and Retinal Detachments

Intravitreal injections, including those with IZERVAY, may be associated with endophthalmitis and retinal detachments. Proper aseptic injection technique must always be used when administering IZERVAY in order to minimize the risk of endophthalmitis. Patients should be instructed to report any symptoms suggestive of endophthalmitis or retinal detachment without delay and should be managed appropriately.

# EVERY MONTH MATTERS WHEN TREATING GA

  
**izervay**<sup>™</sup>  
(avacincaptad pegol  
intravitreal solution) 2 mg



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[IZERVAYecp.com](https://www.izervayecp.com)

## Neovascular AMD

In clinical trials, use of IZERVAY was associated with increased rates of neovascular (wet) AMD or choroidal neovascularization (7% when administered monthly and 4% in the sham group) by Month 12. Patients receiving IZERVAY should be monitored for signs of neovascular AMD.

## Increase in Intraocular Pressure

Transient increases in intraocular pressure (IOP) may occur after any intravitreal injection, including with IZERVAY. Perfusion of the optic nerve head should be monitored following the injection and managed appropriately.

## ADVERSE REACTIONS

Most common adverse reactions (incidence  $\geq 5\%$ ) reported in patients receiving IZERVAY were conjunctival hemorrhage, increased IOP, blurred vision, and neovascular age-related macular degeneration.

**Please see full Prescribing Information for more information.**

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US-AP-2300334 V1 03/24



## IZERVAY™ (avacincaptad pegol intravitreal solution)

Rx only

**Brief Summary:** This information is not comprehensive. Visit IZERVAYecp.com to obtain the FDA-approved product labeling or call 609-474-6755.

### 1 INDICATIONS AND USAGE

IZERVAY is indicated for the treatment of geographic atrophy (GA) secondary to age-related macular degeneration (AMD).

### 2 DOSAGE AND ADMINISTRATION

#### 2.1 General Dosing Information

IZERVAY must be administered by a qualified physician.

#### 2.2 Recommended Dosage

The recommended dose for IZERVAY is 2 mg (0.1 mL of 20 mg/mL solution) administered by intravitreal injection to each affected eye once monthly (approximately every 28 ± 7 days) for up to 12 months.

#### 2.4 Injection Procedure

Only 0.1 mL (2 mg) should be administered to deliver a single dose. Any excess volume should be disposed.

Prior to the intravitreal injection, patients should be monitored for elevated intraocular pressure (IOP) using tonometry. If necessary, ocular hypotensive medication can be given to lower the IOP.

The intravitreal injection procedure must be carried out under controlled aseptic conditions, which includes the use of surgical hand disinfection, sterile gloves, a sterile drape, and a sterile eyelid speculum (or equivalent). Adequate anesthesia

and a broad-spectrum topical microbicide should be given prior to the injection.

Inject slowly until the rubber stopper reaches the end of the syringe to deliver the volume of 0.1 mL. Confirm delivery of the full dose by checking that the rubber stopper has reached the end of the syringe barrel.

Immediately following the intravitreal injection, patients should be monitored for elevation in intraocular pressure (IOP). Appropriate monitoring may consist of a check for perfusion of the optic nerve head or tonometry.

Following intravitreal injection, patients should be instructed to report any symptoms suggestive of endophthalmitis (e.g., eye pain, redness of the eye, photophobia, blurring of vision) without delay.

Each vial and syringe should only be used for the treatment of a single eye. If the contralateral eye requires treatment, a new vial and syringe should be used and the sterile field, syringe, gloves, drapes, eyelid speculum, filter needle, and injection needle should be changed before IZERVAY is administered to the other eye. Repeat the same procedure steps as above.

Any unused medicinal product or waste material should be disposed of in accordance with local regulations.

### 3 DOSAGE FORMS AND STRENGTHS

Intravitreal solution: 20 mg/mL clear to slightly opalescent, colorless to slightly yellow solution in a single-dose vial.

### 4 CONTRAINDICATIONS

#### 4.1 Ocular or Periocular Infections

IZERVAY is contraindicated in patients with ocular or periocular infections.

#### 4.2 Active Intraocular Inflammation

IZERVAY is contraindicated in patients with active intraocular inflammation.

### 5 WARNINGS AND PRECAUTIONS

#### 5.1 Endophthalmitis and Retinal Detachments

Intravitreal injections may be associated with endophthalmitis and retinal detachments. Proper aseptic injection techniques must always be used when administering IZERVAY in order to minimize the risk of endophthalmitis. Patients should be instructed to report any symptoms suggestive of endophthalmitis or retinal detachment without delay, to permit prompt and appropriate management.

#### 5.2 Neovascular AMD

In clinical trials, use of IZERVAY was associated with increased rates of neovascular (wet) AMD or choroidal neovascularization (7% when administered monthly and 4% in the sham group) by Month 12. Patients receiving IZERVAY should be monitored for signs of neovascular AMD.

#### 5.3 Increase in Intraocular Pressure

Transient increases in intraocular pressure (IOP) have been observed after an intravitreal injection, including with IZERVAY. Perfusion of the optic nerve head should be monitored following the injection and managed as needed.

### 6 ADVERSE REACTIONS

The following potentially serious adverse reactions are described elsewhere in the labeling:

- Ocular and periocular infections
- Neovascular AMD
- Active intraocular inflammation
- Increase in intraocular pressure
- Endophthalmitis and retinal detachments

#### 6.1 Clinical Trials Experience

Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

The safety of avacincaptad pegol was evaluated in 733 patients with AMD in two sham-

controlled studies (GATHER1 and GATHER2). Of these patients, 292 were treated with intravitreal IZERVAY 2 mg (0.1 mL of 20 mg/mL solution). Three hundred thirty-two (332) patients were assigned to sham.

Adverse reactions reported in ≥2% of patients who received treatment with IZERVAY pooled across GATHER1 and GATHER2, are listed below in Table 1.

**Table 1: Common Ocular Adverse Reactions (≥2%) and greater than Sham in Study Eye**

Adverse Drug Reactions	IZERVAY N = 292	Sham N = 332
Conjunctival hemorrhage	13%	9%
Increased IOP	9%	1%
Choroidal neovascularization	7%	4%
Blurred vision*	8%	5%
Eye pain	4%	3%
Vitreous floaters	2%	<1%
Blepharitis	2%	<1%

\* Blurred vision includes visual impairment, vision blurred, visual acuity reduced, visual acuity reduced transiently.

### 8 USE IN SPECIFIC POPULATIONS

#### 8.1 Pregnancy

##### Risk Summary

There are no adequate and well-controlled studies of IZERVAY administration in pregnant women. The use of IZERVAY may be considered following an assessment of the risks and benefits.

Administration of avacincaptad pegol to pregnant rats and rabbits throughout the period of organogenesis resulted in no evidence of adverse effects to the fetus or pregnant female at intravenous (IV) doses 5.1 times and 3.2 times the human exposure (based on AUC) at the maximum recommended human dose (MRHD) of 2 mg once monthly, respectively.

In the U.S. general population, the estimated background risks of major birth defects and miscarriage in clinically recognized pregnancies is 2-4% and 15%-20%, respectively.

#### Animal Data

An embryo fetal developmental toxicity study was conducted with pregnant rats. Pregnant rats received daily intravenous (IV) injections of avacincaptad pegol from day 6 to day 17 of gestation at 0.1, 0.4, 1.2 mg/kg/day. No maternal or embryofetal adverse effects were observed at any dose evaluated. An increase in the incidence of a non-adverse skeletal variation, described as short thoracolumbar (ossification site without distal cartilage) supernumerary ribs, was observed at all doses evaluated. The clinical relevance of this finding is unknown. Plasma exposures at the high dose were 5.1 times the MRHD, based on Area Under the Curve (AUC).

An embryo fetal developmental toxicity study was conducted with pregnant rabbits. Pregnant rabbits received daily IV injections of avacincaptad pegol from day 7 to day 19 of gestation at 0.12, 0.4, 1.2 mg/kg/day. No maternal or embryofetal adverse effects were observed at any dose evaluated. Plasma exposure in pregnant rabbits at the highest dose of 1.2 mg/kg/day was 3.2 times the human exposure at the MRHD, based on AUC.

#### 8.2 Lactation

There is no information regarding the presence of avacincaptad pegol in human milk, the effects of the drug on the breastfed infant or on milk production.

The developmental and health benefits of breastfeeding should be considered along with the mother's clinical need for IZERVAY and any potential adverse effects on the breastfed infant from IZERVAY.

#### 8.4 Pediatric Use

Safety and effectiveness of IZERVAY in pediatric patients have not been established.

#### 8.5 Geriatric Use

Of the total number of patients who received IZERVAY in the two clinical trials, 90% (263/292) were ≥65 years and 61% (178/292) were ≥75 years of age. No significant differences in efficacy or safety of avacincaptad pegol were seen with increasing age in these studies. No dose adjustment is required in patients 65 years and above.

### 17 PATIENT COUNSELING INFORMATION

Advise patients that following IZERVAY administration, patients are at risk of developing neovascular AMD, endophthalmitis, elevated intraocular pressure and retinal detachments. If the eye becomes red, sensitive to light, painful, or if a patient develops a change in vision, instruct the patient to seek immediate care from an ophthalmologist.

Patients may experience temporary visual disturbances and blurring after an intravitreal injection with IZERVAY and the associated eye examinations. Advise patients not to drive or use machinery until visual function has recovered sufficiently.

Manufactured by:

IVERIC bio, Inc., An Astellas Company. Parsippany, NJ 07054

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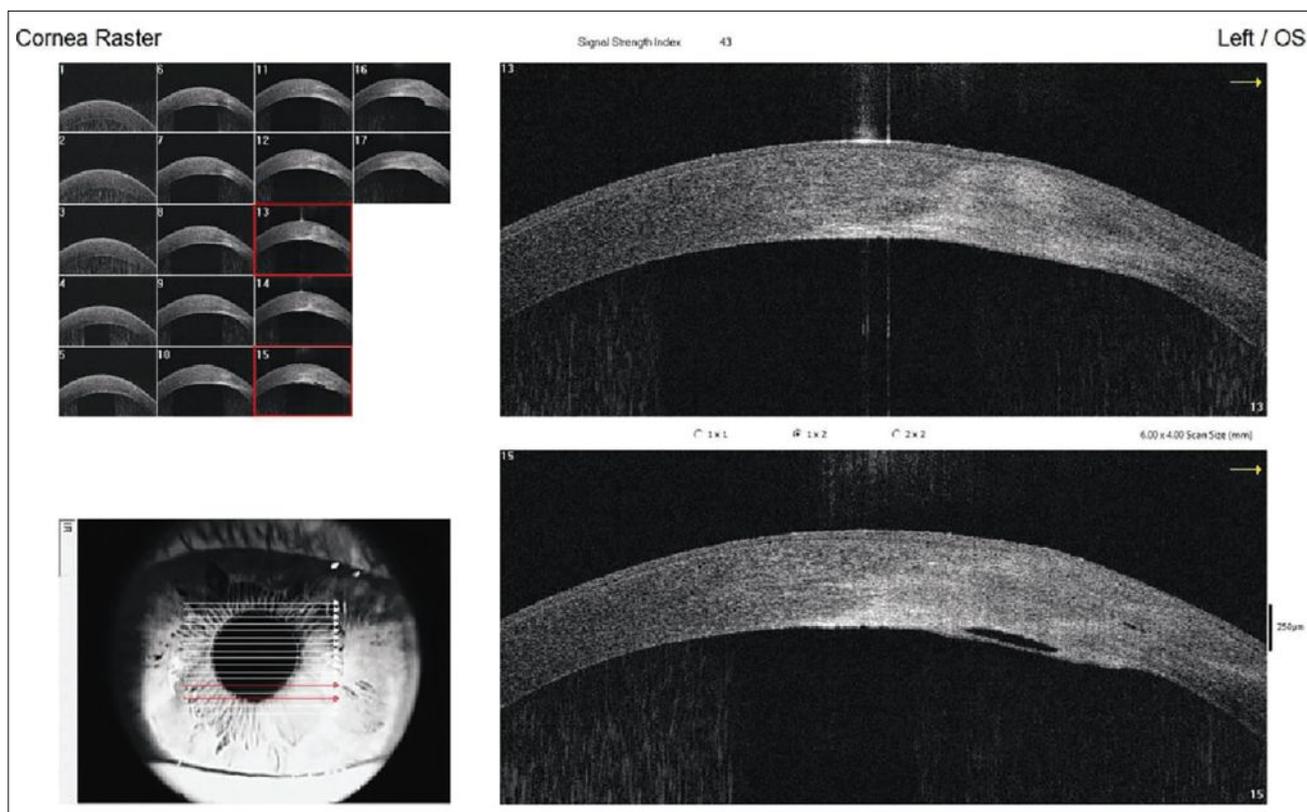


Photo: Sharon Keh, OD, Irene Frantzis, OD, and Yana Sevriam, OD

**Fig. 2.** This AS-OCT image highlights corneal edema and the break in Descemet's membrane. If there was a dense surface opacity here, the break might have been missed.

### Scheimpflug Imaging

These advanced imaging instruments are employed for the precise measurement of corneal tomography. Named after the Austrian physicist Theodor Scheimpflug, these devices use a unique optical principle to capture detailed 3D images of the entire cornea.<sup>1</sup> Unlike Placido ring topography, Scheimpflug devices excel in providing comprehensive data, including data for anterior and posterior corneal surfaces as well as corneal thickness. The technology relies on a tilted camera that captures images along the Scheimpflug principle which ensures that both the cornea and lens are in sharp focus simultaneously and results in highly-detailed tomographic images.<sup>1</sup>

There are three commonly used Scheimpflug devices: Pentacam (Oculus), Galilei (Ziemer Ophthalmic Systems) and Sirius (Schwind). The former uses a single rotating camera and a static camera, while the latter two combine a Placido topographer

with a single- and a dual-rotating Scheimpflug camera.<sup>3</sup>

One significant advantage of Scheimpflug devices is their ability to assess the entire cornea and offer a wealth of information for diagnostic and surgical planning purposes. These devices provide detailed maps of corneal thickness, which is crucial for detecting subclinical or early keratoconus and refractive surgeries. Scheimpflug imaging can detect subtle changes in corneal structure, which makes it valuable for monitoring disease progression and evaluating treatment outcomes. The obtained three-dimensional data enhances assessment precision and accuracy and contributes to improved clinical decision-making. The Scheimpflug principle helps capture data from the peripheral cornea that centrally-located scanning slit-based cameras are not as capable of.<sup>3</sup>

Despite their advantages, Scheimpflug devices also have limitations in certain cases. They require precise

fixation and alignment from the patient during image acquisition. In cases of poor fixation or uncooperative patients, obtaining reliable and accurate images may be challenging and could lead to data inaccuracies. Furthermore, the presence of dense cataracts or corneal opacities can limit Scheimpflug imaging effectiveness.<sup>3</sup> These opacities may obstruct the passage of light through the cornea, resulting in suboptimal images and reduced visibility of corneal structures. Also, these devices can be costly, with the initial investment, maintenance and training costs potentially posing financial challenges for some healthcare facilities. Depending on the region you reside in, availability of these devices may also be limited. If a full three-dimensional analysis of the cornea is desired, obtaining these Scheimpflug images can be time-consuming compared with other corneal imaging methods, since multiple images will need to be taken from different angles before it is analyzed by the system.<sup>3</sup>

Even with these limitations, Scheimpflug imaging remains a cutting-edge technology with significant advantages in corneal tomography. Its ability to provide detailed information about corneal structure, including thickness and curvature, makes it a valuable tool for diagnosing and managing various eye conditions.

### AS-OCT

The final corneal imaging device we will be discussing is AS-OCT. This is a non-invasive imaging technique that has emerged as a valuable tool for measuring corneal tomography. This technology uses low-coherence interferometry to generate high-resolution, 3D images of the cornea, allowing for a comprehensive assessment of its structure.<sup>4</sup>

Currently, there are two main types of OCTs: Fourier-domain and time-domain. Time-domain OCT varies the position of a reference mirror to create cross-sectional images, whereas Fourier-domain OCT has a fixed mirror and relies on an interference between the reference and sample reflections.<sup>3</sup> Fourier-domain has a faster acquisition time than time-domain, which helps Fourier-domain reduce motion artifacts from patients' eye movements and provide better resolution.<sup>3</sup>

A key advantage of AS-OCT in corneal tomography is its ability to provide detailed information about both the anterior and posterior surfaces of the cornea as well as corneal thickness. This comprehensive data is crucial for diagnosing and managing conditions of keratoconus, corneal dystrophies and for preoperative planning in refractive surgeries. AS-OCT enables clinicians to visualize corneal layers with exceptional detail and gain insights into subtle changes in corneal morphology that may not be apparent with other imaging modalities. Another advantage is image acquisition speed, which allows for quick and efficient examinations.<sup>4</sup> However, it is important to note that factors such as proper alignment and fixation are still critical for obtaining accurate measurements with AS-OCT.

While AS-OCT offers numerous advantages in measuring corneal tomography, like the other devices, it is not without its limitations and disadvantages. First, AS-OCT may have limited penetration depth, depending on the presence of corneal opacities or conditions that lead to incomplete visualization of deeper corneal layers.<sup>4</sup> Therefore, obtaining detailed images of the entire cornea may be challenging. AS-OCT images are highly susceptible

to artifacts, which can present due to a variety of factors, such as blinking or motion.<sup>4</sup> Moreover, these devices are moderately expensive and its accessibility can be prohibitive depending on budget constraints. Further, inexperienced operators might face challenges obtaining accurate and reliable measurements. Finally, AS-OCT typically provides a limited field of view per scan taken compared with the other two modalities and it is more tedious to scan the entire cornea if desired.<sup>4</sup>

### Better When Used Together

While Placido ring devices are focused on corneal topography, both Scheimpflug imaging and AS-OCT provide comprehensive corneal tomography. The choice between them depends on your clinical requirements, level of detail needed and factors of cost and availability. To follow are cases where reliance on solely one modality might be clinically misleading, as each technique has its limitations. Here are some scenarios where the use of one imaging device alone may not provide a complete or accurate picture.

**Keratoconus detection.** Placido ring devices may not be as sensitive in detecting early or subtle cases of keratoconus, as they do not offer posterior elevation or corneal thickness measurements.<sup>5</sup> For patients with moderate to high astigmatism measured on Placido ring devices, it may be warranted to employ additional testing with techniques of Scheimpflug imaging or AS-OCT. However, due to the high cost of Scheimpflug imaging devices such as Pentacam, there is an argument for the expansion of corneal topography scans to be completed more often as part of the routine comprehensive examination. Regardless of the imaging device that you have access to, it is critical to image these subsets of patients to detect corneal disease as early as possible. Advanced cases with significant irregularities might also be better visualized with more detailed Scheimpflug imaging or AS-OCT.

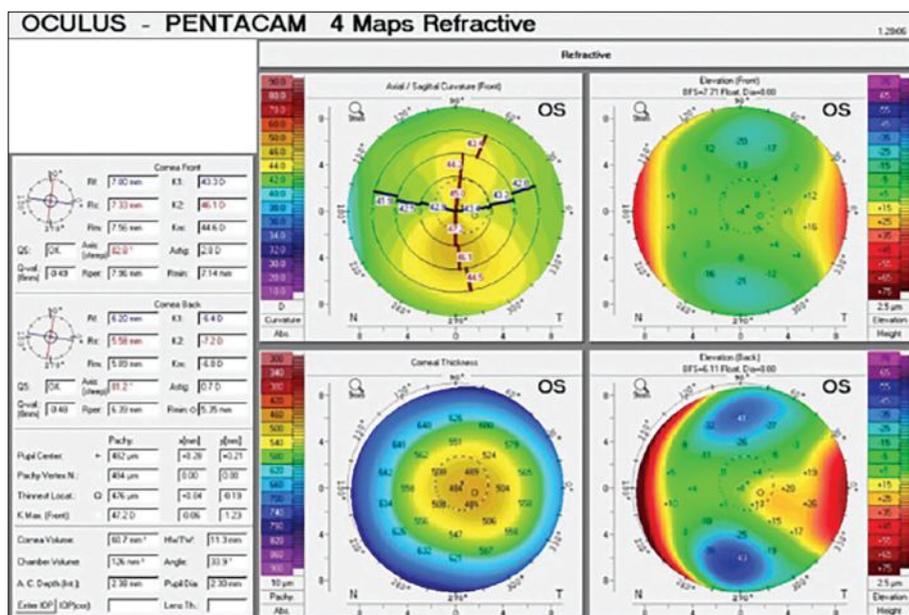


Fig. 3. Pentacam four maps refractive scan OS of a keratoconus suspect.

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‡Antioxidant protects HA from free radicals.

**TABLE 1. CORNEAL TOMOGRAPHER PARAMETERS**

Mean Keratometry	>46.10
Maximum Anterior Elevation in 5 mm Zone	>26.95µm
Maximum Posterior Elevation in 5 mm Zone	>48.72µm
Index of Vertical Asymmetry	>26.95µm
Index of Surface Variance	>62
Keratoconus Index	>1.15
Central Keratoconus Index	>1.03
Index of Height Asymmetry	>20.90
Index of Height Decentration	>0.051
Minimal Sagittal Curvature	<6.59mm
Minimum Corneal Thickness	<473µm
Average Pachymetric Progression Index	>1.80
Maximum Pachymetric Progression Index	>2.55
Maximum Ambrosio Relational Thickness	<282µm
Average Ambrosio Relational Thickness	<202µm
Belin/Ambrosio Enhanced Ectasia Total Deviation Value	>6.94
Root Mean Square Total	>6.64
Root Mean Square Higher Order Aberration	>1.70
3rd Order Vertical Coma Aberration of Cornea Front	>-4.68µm
5th Order Vertical Coma Aberration of Cornea Front	>0.535µm

Adapted from Hashemi H, Beiranvand A, Yekta A, Maleki A, Yazdani N, Khabazkhoob M, et al. Pentacam top indices for diagnosing subclinical and definite keratoconus. *J Curr Ophthalmol*. 2016;28(1):21-26.

**Tear film instability.** Placido ring devices may also result in misleading data from meibomian gland dysfunction prevalence, depending on the patient.<sup>6</sup> Since Placido ring devices are tear film dependent, an unstable tear film may result in misleading information on the imaging results. *Figure 1* shows an example of noninvasive tear breakup assessments.

It is therefore imperative to remember what each device relies on to develop its images prior to sending the patient for image acquisition. For example, if it is already evident upon

slit lamp examination that the patient has decreased tear meniscus or decreased tear break-up time, it may be helpful to instill a drop of artificial tears prior to sending the patient for a corneal topography scan with a Placido disc device. In practice settings where testing is done prior to slit lamp examination, optometric technicians can be trained to look for clear mires and to capture images just after blink to minimize the tear film dependency of Placido ring imaging devices.

**Dense corneal opacities.** Deeper layers of the cornea can potentially be missed when viewed on an AS-OCT.<sup>4</sup> If only the anterior surface of the cornea can be adequately imaged due to the density of the opacity, then areas of the posterior cornea may be missed, despite the device’s capabilities as a corneal tomographer. *Figure 2* shows an AS-OCT image of a resolving corneal hydrops in a patient with keratoconus.

**Posterior segment abnormalities.** While Scheimpflug imaging provides excellent information about the anterior and posterior corneal surfaces, it may not capture details of abnormalities in the posterior segment of the eye beyond the cornea. OCT may be necessary to appropriately image posterior segment findings. Conditions that affect the lens or the posterior chamber may not be fully assessed. This, however, can be remedied by a multimodal imaging approach.

In clinical practice, a multimodal imaging approach is often preferred to overcome the limitations of individual

techniques. Combining Placido ring devices, Scheimpflug imaging and AS-OCT allows for a more thorough evaluation of the cornea and anterior segment, enhancing the clinician’s ability to make accurate diagnoses and informed treatment decisions. Integrating clinical judgment with data from multiple sources ensures a more comprehensive understanding of the patient’s ocular health. However, this may not always be possible, depending on the budget and technology available in each practice setting. Considering that corneal topography and corneal tomography are both billed under the same Current Procedural Treatment (CPT) code—92025—it may be difficult to purchase a significantly more expensive imaging modality, depending on patient population and practice setting.

Even so, there is the potential for variability of posterior corneal surface and thickness measurements between Placido-Scheimpflug and swept-source OCT imaging.<sup>7</sup> There are relatively consistent measurements of horizontal white-to-white and horizontal-vertical iris diameter within each imaging device, but be aware of significant variability when comparing between devices.<sup>8</sup> Consequently, the benefits of using multimodal imaging for our patients when trying to discern a proper diagnosis may not carry over when using Scheimpflug-based and OCT-based imaging interchangeably when trying to monitor progression or changes over time.<sup>9</sup>

### Assessing Keratoconus

When considering multimodal imaging options, consider that the different grading systems for keratoconus specifically vary depending on the instrument used. When using the Amsler-Krumeich grading scale, for instance, the scale solely relies on corneal topography.<sup>10</sup> The newer ABCD grading scale from Belin and Duncan consider additional factors of corneal pachymetry, both anterior and posterior corneal surfaces and best spectacle-corrected visual acuity.<sup>11,12</sup> Many of

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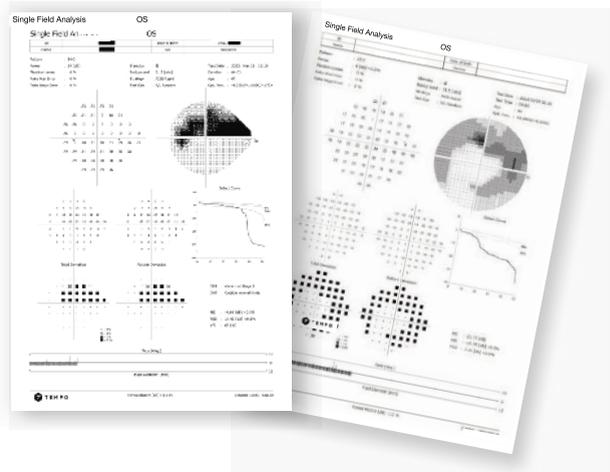
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**Takashi Nishida, MD, PhD**  
**Shiley Eye Center, UC San Diego\***



1. Nishida T, Eslani M, Weinreb RN, Arias J, Vasile C, Mohammadzadeh V, Moghimi S. Perimetric Comparison Between the IMOVifa and Humphrey Field Analyzer. J Glaucoma. 2023 Feb 1;32(2):85-92. doi: 10.1097/IJG.0000000000002134. Epub 2022 Oct 7. PMID: 36223309.

\*Topcon appreciates the contributions from our partners. At times, an honorarium is provided.

these measurements need data from a corneal tomographer to adequately assess the patient on the ABCD grading scale.<sup>5</sup>

In terms of risks and benefits for using one imaging modality over another, there are studies showing that patients with keratoconus who have corneal tomography scans are more likely to undergo corneal collagen crosslinking.<sup>13-16</sup> Early crosslinking may lead to a need for fewer future keratoplasties, and early detection of keratoconus in conjunction with preventative treatment measures can prevent needing more invasive surgical methods.<sup>13-16</sup>

To adequately differentiate between clinical and subclinical keratoconus, the imaging devices measure various parameters to help the practitioner reach a more definitive diagnosis.

Table 1 provides a list of parameters measured by corneal tomographers that can help indicate to the practitioner the presence of definitive keratoconus.

There are various studies in the literature that point to which diagnostic indices are the most impactful in diagnosing clinical and subclinical

keratoconus. The more recent studies were primarily performed on the Pentacam. One in particular measured the Belin/Ambrosio Deviation Display, the fifth order vertical coma aberration, the index of surface variance and the index of vertical asymmetry to be some of the most important indices to watch for in keratoconus diagnosis.<sup>17</sup> For borderline diagnosis cases, Belin/Ambrosio Deviation Display values  $\geq 1.54$ , fifth order vertical coma aberration of the front cornea  $\geq 0.023$ , index of surface variance values  $\geq 22$  and index of vertical asymmetry values  $\geq 0.14$  should also raise suspicion for keratoconus.<sup>17</sup>

In another study, back maximum keratometry, index of vertical asymmetry, inferior-superior difference and root mean square total values were found to be the most accurate indices for diagnosing definitive keratoconus.<sup>18</sup> The study also found that the values to pay close attention to for diagnostic indices with the best specificity and sensitivity for detecting subclinical keratoconus were index of surface variance, index of vertical asymmetry, keratoconus index, posterior radius

of curvature, root mean square high order and back maximum keratometry.<sup>18</sup> Multiple studies reported that the Belin/Ambrosio Enhanced Ectasia Display played a crucial role in detecting subclinical keratoconus.<sup>17-19</sup>

Here is an example of a patient whose refractive error not only showed high astigmatic correction, but the astigmatic correction was also asymmetric. She had no previous remarkable ocular history to note. A Scheimpflug image was taken, and the findings for her left eye are indicated in Figure 3.

If we can pay attention solely to the axial front curvature map and the front elevation map, the cornea looks asymmetric, but depending on the device used, you might not automatically diagnose this patient with a specific condition. With the corneal tomography device, we are also able to obtain the pachymetry measurement, which indicates the patient has thinner than average corneas. When observing the back elevation map along with the front elevation map, you can compare how they look and whether the back elevation is steeper than the front elevation map to indicate ectasia.

For the patient in Figure 4, it looks like only the central point shows a suspicious elevation difference. To the right, you can see a map of the pachymetry values at the apex of the cornea as well as at the thinnest point. Generally, the higher the displacement is of the thinnest pachymetry value from the apex, the more likely it is that the patient has keratoconus. As you can see in the top right panel of the image, there is some displacement of the thinnest pachymetry to the apex. On the bottom right, you can see graphs of the Corneal Thickness Spatial Profile (CTSP) and the Percentage Thickness Increase (PTI). The CTSP shows how the cornea progressively thickens from the thinnest point, and the PTI shows the percentage of increase in corneal thickness

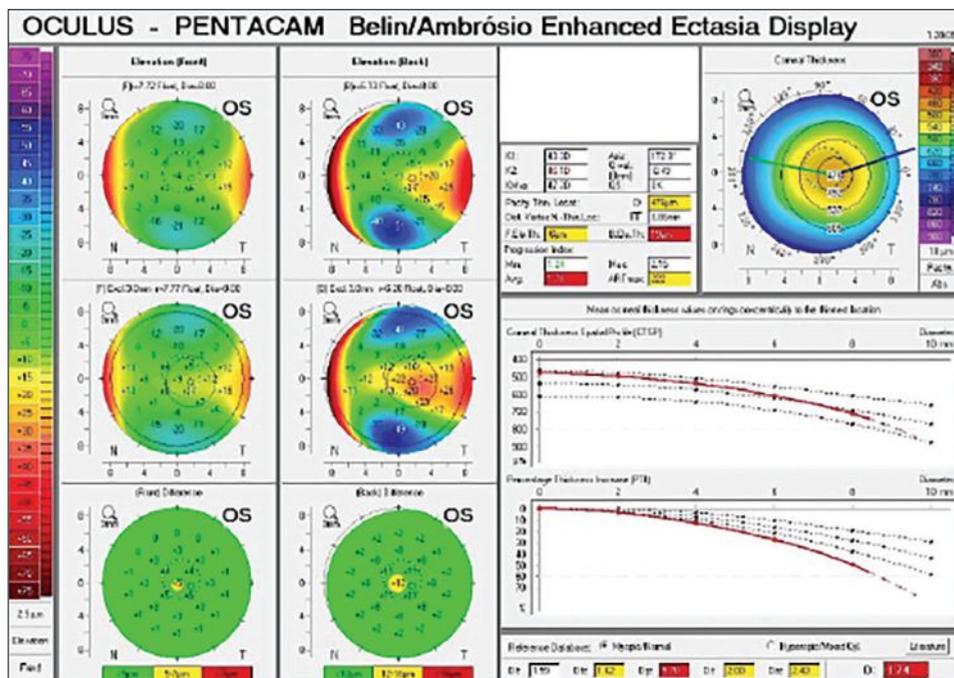
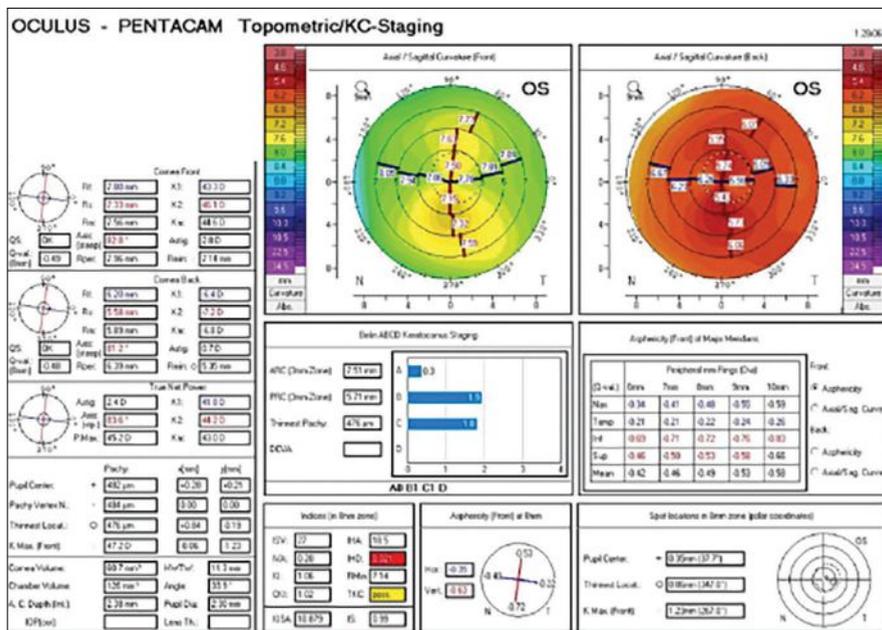


Fig. 4. While the top two maps on the left show the standard and exclusion elevation maps that are used to show the front and back elevation maps in relation to their best fit sphere., The bottom two maps show the elevation differences between front and back surface and will flag areas that are suspicious for greater differences than the norm.<sup>20</sup>



**Fig. 5. Pentacam topometric/keratoconus staging OS of a keratoconus suspect.**

from the thinnest point to the peripheral cornea.<sup>20</sup> Both graphs show a 95% confidence interval with the average normal population in the center.<sup>20</sup>

Comparatively, this patient has a more rapid thickening and higher percentage of thickening than the normal population. Since patients with keratoconus have a more rapid progression of thickening from the thinnest point to the peripheral cornea, there is concern for early ectatic disease.

While there is no universally agreed-upon keratoconus staging method, the topometric/keratoconus staging, pictured in *Figure 5*, shows more information on the Belin ABCD Keratoconus Staging Method. It also offers more information on the asphericity of the front major meridians as well as indices within the 8mm zone of the cornea to evaluate.<sup>11</sup> The ABCD system uses four parameters that are listed in the scan: anterior radius of curvature in the 3.0mm zone centered around the thinnest location, posterior radius of curvature in the same zone as the anterior radius, thinnest pachymetry in microns and distance best-corrected visual acuity.<sup>12</sup>

For this particular patient, the keratoconus staging shows that the patient's posterior radius of curvature

and the thinnest pachymetry are almost at stage 2. The index of height decentration is also considered significantly abnormal and flagged under indices.

The Topographic Keratoconus Classification has this patient listed as possible for keratoconus.

At this point, while there is no clear definitive keratoconus clinically or under all the indices on the corneal tomography scan, there is suspicion for it. Once the patient returns for another corneal tomography scan, we will be able to use the Belin ABCD Progression Display to measure progression over time of the four parameters used in the Belin ABCD Keratoconus Staging Method.<sup>12</sup>

## Takeaways

Interpreting corneal scans requires the clinician to have a nuanced understanding of the specific imaging modality used and the ability to discern clinically relevant information. Regular training and staying current in the advancements in imaging technologies are essential for eyecare professionals to enhance their interpretative skills. Collaboration with colleagues and consultation with cornea specialists can also be valuable in managing our most challenging cases. ■

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# CORNEAL CASES: WHICH ARE RIGHT FOR YOU?

Here's how to evaluate a wide array of presentations and decide whether to accept or send to another provider.



**CHRISTINA CHERNY, OD, AND  
SUZANNE SHERMAN, OD**  
NEW YORK CITY

A wide array of corneal conditions are encountered on a daily basis in most optometric practices and appropriate diagnosis and management are vital to ensure good vision and promote ocular health. While many can be managed by practicing OD in their offices, a variety will require surgical intervention or at least a consult with a cornea or oculoplastics subspecialist. In such cases, prompt referral may be critical to ensuring successful outcomes. Here, we will detail commonly encountered corneal conditions, summarize management and underline when to consider referral.

## Abrasions

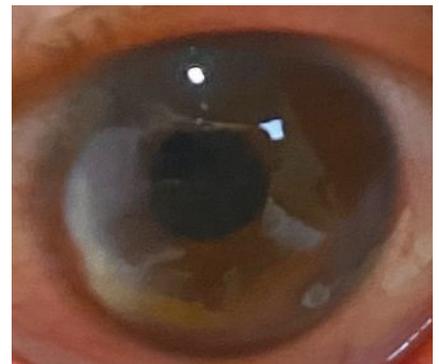
Corneal abrasions occur when mechanical trauma or a foreign object scratches the epithelial surface, as well as from erosive disorders such as epithelial basement membrane dystrophy. These are frequently treated by eyecare providers

and general practitioners alike. Positive sodium fluorescein staining in the setting of pain will be present, along with foreign body sensation, epiphora, redness and occasional decrease in vision.

Oftentimes, corneal abrasions can be treated conservatively with oral pain killers (if legal scope allows) and copious lubrication, although topical antibiotic prophylaxis may be warranted to prevent infections from larger, deeper abrasions with a greater extent of epithelial involvement. Bandage contact lenses should also be considered for pain relief in cases of larger epithelial defects.<sup>1,2</sup> Generally, abrasions can be treated in-house by optometrists, although referral may be necessary for persistent epithelial defects refractory to standard treatment.

## Contact Lens-induced Acute Red Eye (CLARE)

This is an inflammatory process that occurs following long-term closure of the eye in the setting of contact lens wear, as in circumstances where the patient sleeps with their lenses in. CLARE



**Fig. 1. Marginal degeneration.**

results in multiple small, focal infiltrates peripherally in the cornea with negligible overlying staining. Patients present with circumlimbal redness, epiphora, photophobia and moderate pain, typically shortly after waking with contact lenses on.

Treatment begins with a contact lens holiday, frequent lubrication with preservative-free artificial tears and topical antibiotic prophylaxis, with more severe cases requiring topical steroid drops four times daily with taper.<sup>3</sup> Referral is generally not indicated.

### About the authors

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## Contact Lens Peripheral Ulcer (CLPU)

This is another inflammatory process that results in focal epithelial excavation with staining, infiltration and stromal necrosis. Small, focal, circular infiltrates are observed peripherally in the setting of conjunctival redness, epiphora, mild to severe pain and/or foreign body sensation, although some patients are asymptomatic. Diffuse infiltration, erosion and mild anterior chamber reaction may also be noted.

Similar to cases of CLARE, patients are treated with contact lens holiday, frequent lubrication with preservative-free artificial tears, oral analgesics as needed and close monitoring, along with topical antibiotic drops or ointment for prophylaxis.<sup>3</sup> Severe ulceration with imminent perforation would warrant referral to ophthalmology; however, this is generally not seen with CLPU.

## Microbial Keratitis

Some of the more common etiologies for infectious keratitis are extended contact lens wear, severe ocular surface disease and ocular trauma. Pathogens and presentations can vary widely but it's prudent to bear in mind that microbial keratitis can result in corneal opacity and vision loss if not treated promptly.<sup>4</sup>

Differentiating corneal infiltrates as sterile or infectious is critical to ensure proper treatment.<sup>5</sup> Sterile infiltrates are often less than 1.5mm in diameter. Peripheral subepithelial or anterior stromal infiltrates with minimal overlying epithelial involvement are associated with negligible to mild symptoms. Treatment of such infiltrates includes discontinuation of contact lens wear followed by topical antibiotics, antibiotic-steroid combination agents, topical steroids or close observation. Infectious corneal ulcers often present with epithelial disruption overlying the infiltrate with acute, moderate-to-severe symptoms of pain, photophobia, vision decrease, conjunctival injection and mucopurulent discharge.

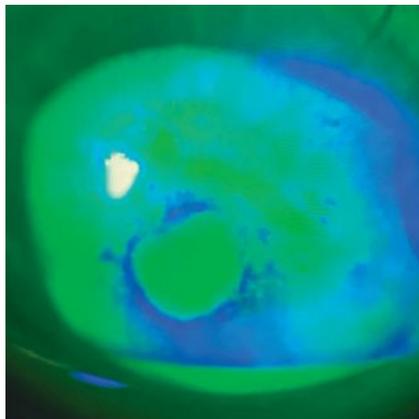


Fig. 2. Neurotrophic corneal ulcer.

Bacterial corneal ulcers may present with a single epithelial defect overlying a stromal infiltrate with indistinct edges, corneal edema, anterior chamber reaction and hypopyon.<sup>6</sup> Other clinical signs associated with bacterial origin include white cell infiltration of nearby stroma. If the ulcer is relatively small and non-visually threatening, empirical treatment with broad spectrum topical antibiotics such as a fourth-generation fluoroquinolone can be initiated immediately. Fortified antibiotic combinations are necessary in larger and sight-threatening ulcers, while severe cases—such as those with significant stromal thinning, corneal perforation and/or endophthalmitis—necessitate prompt referral to a cornea specialist.

In fungal etiologies, associated clinical features include multiple satellite lesions; feathery, fluffy or serrated infiltrate margins; dry, raised or necrotic infiltrates; endothelial rings and a longer clinical course history. While more rare, parasitic etiologies such as *Acanthamoeba* keratitis may present with pseudodendrites, perineural and/or ring-shaped infiltrates, and history of prior topical antibiotic use.<sup>7</sup>

Cultures and smears of infectious corneal ulcers are indicated when any of the following scenarios describes the infiltrates:<sup>8</sup>

- greater than 2mm in size and centrally located
- chronic, multiple or diffuse in nature
- associated by significant stromal melting

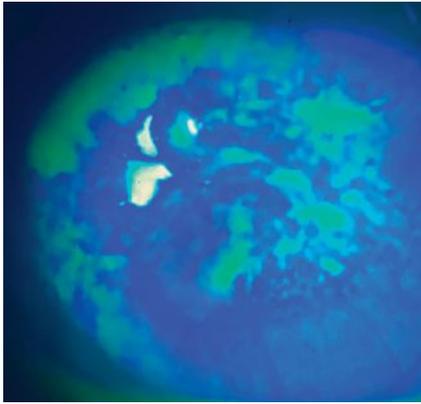
- fail to respond to empiric antibiotic therapy
- present with other signs characteristic of amoebic, mycobacterial or fungal infection
- occur in eyes with prior history of corneal surgery

Fortified antibiotic combinations are necessary in larger and sight-threatening ulcers, while severe cases, such as those with significant stromal thinning, corneal perforation, and/or endophthalmitis necessitating prompt referral to a cornea specialist.

## Viral Keratitis

The two chief culprits here are epidemic keratoconjunctivitis (EKC) and herpetic infection. Viral corneal infections often present with symptoms of pain and photophobia, and may be accompanied by decreased vision. EKC also often presents with diffuse injection and discharge, with keratopathy and subepithelial infiltration occurring several days into the clinical course. Consider performing a betadine rinse to decrease viral load, and note that pseudomembranes must be swept every few days to prevent symblepharon formation within both the inferior and superior palpebral conjunctiva. About one to two weeks into the course of EKC, steroids are used to relieve subepithelial infiltrates and prevent scarring.

Herpetic corneal infections can result from herpes simplex virus, which may present with true dendrite branches with terminal end bulbs, interstitial keratitis or endotheliitis with keratin precipitates and stromal edema, while herpes zoster keratitis may present similarly with pseudodendritic epithelial defects, stromal haze, with or without anterior chamber reaction. The latter can be preceded by vesicular facial lesions distributed along the V1 branch of the trigeminal nerve. Herpetic keratitis is treated with systemic and topical antivirals, with certain cases requiring topical steroids and/or antibiotics.<sup>9</sup> Referral may be warranted for pain management, retinal and/or systemic involvement.



**Fig. 3. Exposure keratopathy secondary to eyelid abnormality.**

### Exposure Keratopathy

When your patient's eyelids cannot close all the way, chances are it's exposure keratitis due to the corneal epithelium drying because of prolonged exposure, typically while sleeping. This occurs in the setting of incomplete closure due to nocturnal lagophthalmos, cranial nerve VII paresis, lagophthalmos during anesthesia, proptosis, eyelid injury and/or malformation.<sup>10</sup> Treatment of mild-to-moderate cases includes frequent lubrication, viscous topical gels or ointments during nighttime, eyelid taping at bedtime and therapeutic contact lens wear. In severe or persistent cases, surgical comanagement with an oculoplastics surgeon is warranted to improve eyelid structure/function or for tarsorrhaphy.<sup>11</sup>

### Recurrent Corneal Erosions (RCE)

These are defined as repeated episodes of epithelial breakdown following eyelid adhesion during sleep, often in the setting of prior corneal injury or with certain corneal dystrophies.<sup>12</sup> Patients present with acute pain, tearing, photophobia and decreased vision, often upon waking, with an epithelial defect with or without loose epithelial tissue noted on exam. Treatments may include lubrication, therapeutic contact lens wear, oral tetracyclines like doxycycline, topical prednisolone, autologous serum eye drops and/or debridement of loose epithelium.

Non-healing RCEs can occur when the epithelium is loose or when medical

therapy fails. After epithelial debridement and extended bandage wear contact lenses have failed, a referral might be necessary for anterior stromal micropuncture, diamond burr polishing of Bowman's membrane or excimer laser phototherapeutic keratectomy (PTK). Stromal puncture is usually reserved for small areas of erosions outside the visual axis, whereas diamond burr polishing and PTK are used for larger areas of erosions.<sup>13</sup> Some states allow optometrists to perform anterior stromal puncture if they are appropriately credentialed in the procedure. As always, use appropriate discretion.

### Keratoconus

This condition is a bilateral, asymmetric and progressive thinning and steepening of the cornea, resulting in irregular astigmatism and decreased vision. Patients present with blurry vision and/or ghosting (monocular diplopia). Clinical findings may include corneal thinning and steepening (often in the central or paracentral stroma), scissoring reflex on retinoscopy, Charleux's oil droplet reflex on dilated retroillumination, Fleischer's ring, Vogt's striae and apical corneal scarring. Keratoconic patterns on the axial curvature map on corneal topography confirm the diagnosis.

Mild cases can be managed with spectacles or soft contact lenses, while more moderate to advanced cases typically require specialty contact lenses or corneal transplantation, particularly if visually limiting scarring is present. In all cases, patients are educated to avoid eye rubbing. Corneal crosslinking is a minor procedure that prevents keratoconus progression by improving corneal biomechanical stability; given its favorable safety and efficacy profile, it should be discussed with all newly diagnosed cases, especially in childhood. Clear progression warrants referral to a cornea specialist.

In certain severe cases of keratoconus, a complication known as hydrops may occur in which a break in Descemet's membrane results in corneal edema and haze. Though this condition may be self-limiting, topical hyperosmotic

agents, steroids and beta blockers may expedite resolution. Corneal suturing with intracameral gas injection or tamponades may be used to promote resolution prompting referral to a cornea specialist.<sup>14</sup>

### Corneal Dystrophies

These diseases are generally hereditary, bilateral ocular disorders that affect one or several corneal layers and present with distinct morphologies. The conditions are slowly progressive and may result in corneal opacification.<sup>15</sup>

Optometrists are able to conservatively treat functional symptoms of corneal dystrophies such as vision loss, photophobia, foreign body sensation, pain and cosmesis concerns, as well as the sequelae of corneal erosions. This includes the use of lubrication, therapeutic contact lenses and/or hyperosmotic agents. Referral to ophthalmology is indicated when conservative measures are insufficient and it is time to consider procedures such as PK or keratoplasty.

Anterior dystrophies may end up needing similar treatments as non-healing RCEs, including anterior stromal puncture, diamond burr polishing or excimer laser PTK. Stromal dystrophies may need more invasive procedures such as superficial keratectomy, PTK, deep anterior lamellar keratoplasty or a penetrating keratoplasty. Full-thickness transplants are usually reserved for severe, visually limiting corneal opacities. Posterior corneal dystrophies can often be managed without surgery; if unsuccessful, endothelial transplants are performed.

### Fuchs' Endothelial Corneal Dystrophy (FECD)

This is a progressive decline of corneal endothelial cells that results in apoptosis, size variation (polymegethism), shape variation (pleomorphism) and ultimately formation of excrescences called guttae.<sup>16</sup> With time, fluid accumulates within the stroma resulting in corneal edema and vision loss.

Early FECD is typically observed with serial pachymetry and may be asymptomatic or present with reduced

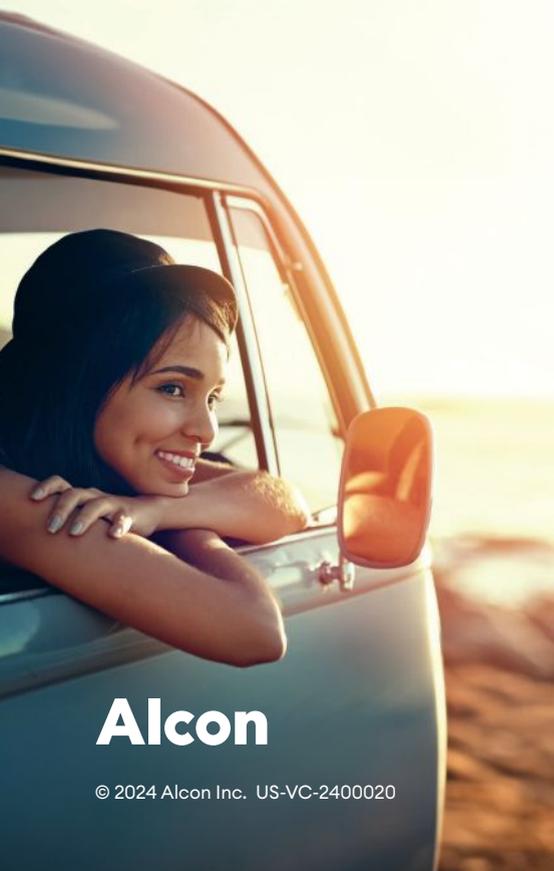
# THE INTUITIVE ONE

## EMPOWERING PATIENTS WITH A MORE INTUITIVE REPLACEMENT SCHEDULE

THE INDUSTRY HAS SPOKEN: 82%\* OF OPTOMETRISTS SURVEYED AGREED SHORTER CONTACT LENS SCHEDULES ARE A BETTER CHOICE FOR THEIR PATIENTS.<sup>1</sup>

*"More compliant contact lens wearers have better eye health and more positive outcomes.<sup>4</sup> This leads to happier patients and greater patient retention.<sup>5"</sup>*

— Jennifer S. Harthan



**Alcon**

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Eye care professionals (ECPs) are continually seeking ways to optimize both patient outcomes and practice efficiency. One area ripe for re-evaluation is the replacement schedule for contact lenses. While two-week replacement schedules have been a mainstay in many practices, there's growing recognition that this common replacement schedule might not be as intuitive as it could be — and, in many cases, doesn't align with patients' lifestyles.

### INTUITIVENESS AND COMPLIANCE IN REPLACEMENT SCHEDULES

While so many habits, from grocery shopping and meal prep to changing bedding and paying bills, happen weekly or monthly, very little is on a twice-monthly schedule.

Ultimately, patients on a two-week contact lens replacement schedule must remember this lens change, which may not coincide with natural cycles they're likely accustomed to following. Not surprisingly, then, two-week contact lenses are the least compliant replacement schedule.<sup>2,3</sup>

Other challenges with a two-week replacement schedule?

#### #1. LESS COMPLIANCE LEADS TO LOWER PATIENT SATISFACTION

More compliant contact lens wearers have better eye health and more positive outcomes.<sup>4</sup> This leads to happier patients and greater patient retention.<sup>5</sup>

#### #2. CONTACT LENS DEPOSITION

Replacement schedules can play an important role in deposition. Shifting to a shorter replacement schedule may result in less lens deposition.<sup>6-8</sup>

#### #3. STRONGER PRACTICE CONNECTIONS

Shorter replacement schedules come with many advantages for patients and practices. Two-week lenses are the least compliant replacement schedule<sup>2,3</sup> — and more compliant wearers return to their eye doctors an average of three months sooner than non-compliant patients.<sup>7</sup>

What's more, shorter replacement schedules may encourage regular, consistent purchases and timely comprehensive eye care. Moreover, patients visiting their eye doctors' offices more provides increased opportunities to create personal connections, engage in added care conversations, and build a stronger patient-provider relationship.

#### #4. SETTING A NEW STANDARD IN EYE CARE

Ultimately, recommending an intuitive replacement schedule positions a practice as progressive and patient-centric. Embracing shorter replacement schedules shows that a practice is in tune with the latest industry trends and patient preferences, potentially setting it apart in a competitive market.

## TWO-WEEK CONTACT LENSES ARE THE LEAST COMPLIANT REPLACEMENT SCHEDULE

### STARTING THE CONVERSATION WITH YOUR PATIENTS

Today's patients look for simplicity and convenience in all aspects of life, including eye care. A more intuitive replacement schedule resonates because it syncs with other weekly tasks and naturally reduces cognitive load.

Your next step: start the conversation. By checking in with contact lens wearers, frequently assessing their real-time needs, and adopting practices that serve those best interests, you'll be well-positioned to recommend replacement schedules that align. And that leads to satisfied, loyal patients, now and in the future.

\*U.S. optometrists who fit contact lenses

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vision and halos upon waking. Conservative treatment includes hypertonic saline drops or ointment, as well as topical steroids. As the disease progresses, patients may experience decreased vision, photophobia, pain and epiphora if epithelial bullae rupture. Bandage contact lenses provide symptomatic relief. In more advanced cases, endothelial keratoplasty is recommended and warrants referral to a cornea specialist.

### **Marginal Keratitis**

In this common inflammatory condition, sterile peripheral corneal infiltrates develop in the peripheral corneal abutting the eyelid margin in the setting of blepharitis.<sup>17</sup> Patients present with symptoms of redness, photophobia and foreign body sensation and are treated with a combination of topical antibiotics and steroids, as well as lid hygiene. Referral is generally not warranted.

### **Corneal Burn**

Chemical injury is an emergency that requires prompt treatment. Determining the causative agent is helpful to classify severity, as alkali penetrate cell membranes and are more destructive than acidic agents. Chemical exposure may result in scarring, forniceal shortening, symblephara and cicatricial ectropion/entropion. Severe burns to the limbal stem cells may cause limbal stem cell deficiency, with opacification and eventual neovascularization of the cornea.

Treatment begins with immediate copious lubrication until the ocular surface pH reaches 7.0 to 7.2. Fornices should be swept with eyelid eversion to remove particles, if present, and intraoc-

ular pressure (IOP) should be measured. For milder injuries, topical antibiotic ointment and preservative-free artificial tears are sufficient, with a short pulse of topical steroid to control inflammation. A topical cycloplegic agent may be applied for comfort, and patients should be monitored closely for improvement.

In more severe burns, a longer course of topical steroids is needed along with a longer-acting cycloplegic agent, topical broad-spectrum antibiotic and oral tetracycline, as well as high-dose vitamin C. IOP can be controlled with aqueous suppressants if needed. Significant burns may also warrant corneal debridement and amniotic membrane placement, along with referral to a specialist.<sup>18,19</sup>

### **Perforation**

A full-thickness hole in the cornea is deemed a perforation. The etiology of this can vary greatly and includes infectious, inflammatory, traumatic and medication-induced causes. Symptoms involve acute or constant tearing, redness, photophobia, pain and vision loss.

Depending on the etiology, surrounding preexisting pathology may be seen. If a shallow or flat anterior chamber involving iridocorneal touch presents, this indicates that the corneal perforation needs to be repaired within 24 to 48 hours in order to prevent severe anterior segment damage. A Seidel test may result in a positive sign. Descemet's folds may be present in a radiating form near the perforation site. Iris prolapse may be seen incarcerated from the perforation, and the pupil may be deformed or irregular. Often the eye will feel soft on palpation; however, rarely it can be firm.

Any kind of perforation requires an immediate referral, with the size of the perforation determining the nature of the treatment. A pinpoint perforation (<0.5mm) can be treated with a bandage contact lens and aqueous suppressants. If the Seidel signs remains positive or the anterior chamber does not fill, then more aggressive treatments must be undertaken. A small or medium perforation (0.5mm to 2mm) can be treated with cyanoacrylate tissue adhesive and then covered with a bandage contact lens.

The cyanoacrylate glue will polymerize within seconds, forming a strong bond of the tissue, then healing and re-epithelization will take place over time. Ultimately, once the re-epithelization has occurred, the glue will dislodge. The bandage contact lens helps with patient comfort and prevents the glue from initially dislodging.

A large perforation (>2mm) that is peripheral may need a lamellar or full-thickness patch graft. Usually fresh or cryopreserved corneal or scleral tissue is used. If the perforation is large and central, a penetrating keratoplasty has to be performed.<sup>13</sup>

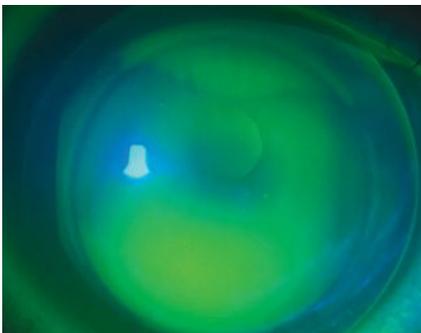
### **Interstitial Keratitis**

This is characterized by stromal inflammation and vascularization without epithelial involvement and can occur due to herpetic disease or congenital syphilis, although other systemic etiologies may apply. During the active inflammatory stage, patients may be symptomatic for pain, epiphora, photophobia and blepharospasm, and signs include perilimbal injection, fine endothelial keratic precipitates and concomitant iritis.

Stromal vascularization will result in ghost vessels, and corneal scarring and thinning may occur with time.<sup>20</sup> Treatment involves topical corticosteroids; however, adjunctive treatment of topical or systemic antivirals, antibiotics or antiparasitics may be warranted for their respective etiologies, as well as treatment of systemic disease.<sup>21</sup> Comanagement with cornea is beneficial, and systemic work-up is warranted to determine underlying pathology.

### **Salzmann's Nodular Degeneration**

This is a slow, progressive condition that is unilateral or bilateral, characterized by small, smooth gray-white elevated lesions usually on the peripheral cornea. These patients often have a history of chronic keratopathy. Often patients are asymptomatic, but when the nodules are located more central or become very elevated, they can cause decreased vision and/or a foreign body sensation. Some may do well with rigid contact lenses, or they may be referred for



**Fig. 4. Keratoconus managed with gas permeable contact lens.**

# Look for choroidal hypertransmission, a marker of Geographic Atrophy (GA) on OCT<sup>1\*</sup>

- While BCVA is poorly correlated to lesion size, visual function continues to decline as lesions grow<sup>2,3</sup>
- It is critical to recognize GA and refer patients in a timely manner, as disease progression is relentless and irreversible<sup>1,3-7</sup>

Learn more about identifying GA  
at [RecognizeAndReferGA.com](https://RecognizeAndReferGA.com)



**RECOGNIZE  
AND REFER**

\*GA is defined by atrophic lesions, resulting from loss of photoreceptors, RPE, and underlying choriocapillaris. This results in a choroidal hypertransmission defect on OCT.<sup>1,4,9</sup>  
BCVA=best-corrected visual acuity; OCT=optical coherence tomography; RPE=retinal pigment epithelium.

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superficial keratectomy with a blade or excimer laser PTK with possible topical mitomycin C at the time of excision to prevent recurrence. Occasionally, lamellar keratoplasties are performed if the nodules are extremely severe.

### Pingueculae and Pterygia

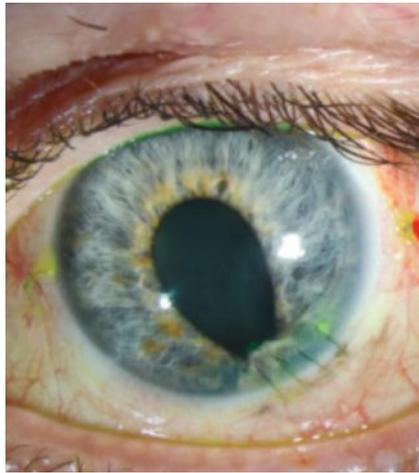
Most of these growths on the conjunctiva can be managed conservatively, with lubrication and UV protection. They should be referred if there is any suspicion of malignancy, such as with conjunctival intraepithelial neoplasia or ocular surface squamous neoplasia.

If a pterygium is visually significant or causes a constant foreign body sensation that cannot be treated topically, the patient will benefit from a referral. Surgical excision of a pterygium is often combined with a conjunctival autograft or an amniotic membrane. Intraoperative application of mitomycin C may be used to reduce post-op recurrence but is often not necessary when a conjunctival autograft is performed. It is important these patients know and understand that pterygia can recur in about 10% to 15% of cases.

### Limbal Stem Cell Deficiency

This is where limbal stem cells are damaged by burns, contact lens wear, surgery, trauma or underlying genetic autoimmune conditions. Patients may experience symptoms of redness, discomfort, pain, tearing or photophobia, with vision loss in severe cases. Clinical exam may reveal epithelial stippling and progressive corneal conjunctivalization and vascularization.

Partial limbal stem cell deficiency sparing the visual axis is rehabilitated with glasses or rigid contact lenses that vault over the limbus. If the visual axis is involved, amniotic membrane placement or autologous or allogenic limbal stem cell transplantation may be warranted, necessitating referral. Severe vision loss may be improved with keratoplasty (usually combined with stem cell transplant) or keratoprosthesis placement by a cornea specialist. Concurrent management of systemic and ocular comorbidities is essential.<sup>22</sup>



**Fig. 5. Status post-repair of penetrating corneal injury with perforation.**

### Neurotrophic Keratopathy

This disease stems from impairment to the trigeminal nerve secondary to systemic disease, trauma/surgery, drug toxicity, herpetic infection or contact lens wear. Impaired corneal sensation leads to impaired healing that can result in epithelial breakdown, ulceration, melting and/or scarring. Patients may present with foreign body sensation, redness, photophobia and decreased/fluctuating vision. Due to hypoesthesia, discomfort may be reduced or absent.

Treatment begins by optimizing the ocular surface by removing agents such as benzalkonium chloride and thimerosal. Address active infections with antibiotic or antiviral agents. Treat concomitant dry eye disease, blepharitis and/or inflammation with topical antibiotics and steroids, oral tetracyclines and/or topical immunomodulators, and use bandage contact lenses, amniotic membranes, autologous serum drops and tarsorrhaphy for significant punctate epitheliopathy or persistent epithelial defects. Direct treatment includes topical cenegermin drops, corneal neurotization (a multispecialty surgical procedure) and platelet-rich plasma, the latter two options warranting referral.<sup>23</sup>

### Takeaways

Proper diagnosis and management of all corneal conditions are key to ensure favorable outcomes for patients. When conservative measures and noninvasive

treatments are insufficient, prompt referral to ophthalmology and effective comanagement is vital for success. ■

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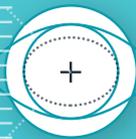
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# ADVANCES IN ENDOTHELIAL SURGERY: AN UPDATE FOR ODs

DMEK remains the current procedure of choice, but newer techniques may obviate the need for donor tissue entirely. Read on to learn the current state of the art and, perhaps, glimpse the future.



KATHLEEN KELLEY, OD,  
FRANCIS PRICE, JR., MD,  
AND MARIANNE PRICE, PhD  
INDIANAPOLIS, IN

Over the last few years, there have been radical changes in the treatments for corneal endothelial disease that have impacted the care optometrists provide to their patients. The most common cause of endothelial dysfunction is Fuchs' dystrophy, which initially causes deposits on the posterior surface of the cornea called guttae (Latin for *drops*). Like rain drops on a windshield, they decrease vision, cause glare and even distort or diminish color vision. As Fuchs' progresses, stromal edema develops—often worse in the morning—and like other forms of endothelial dysfunction, the edema causes even more visual loss, just like fog on a windshield.

As our treatments evolve and become more effective for Fuchs' dystrophy and other forms of endothelial dysfunction, intervention often occurs much earlier in the disease process. For

instance, we sometimes perform Descemet's membrane endothelial keratoplasty (DMEK) for patients with 20/20 vision in a dark room assessed with our typical high contrast Snellen charts. In fact, studies have shown that visual outcomes tend to be better with earlier intervention.

This article will describe where we are with these treatments, what's on the horizon and where they fit into care of these conditions.

## The Gold Standard

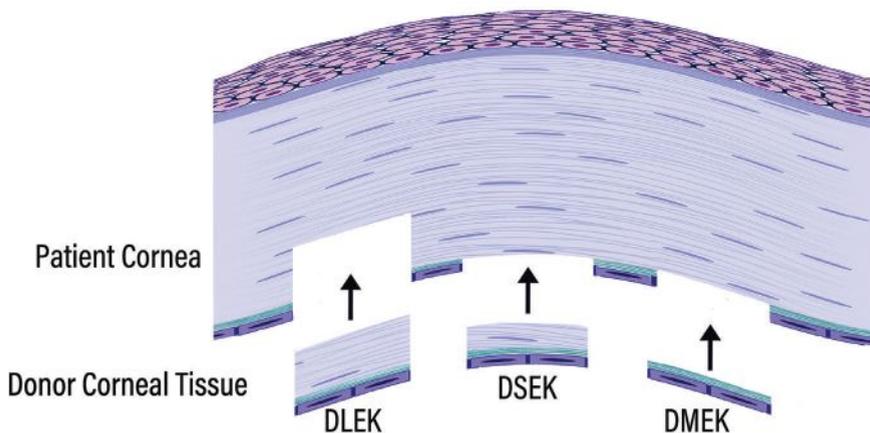
Endothelial keratoplasty (EK) has become the surgery of choice for corneal endothelial dysfunction. First introduced in 1998 by Gerrit Melles, MD, PhD, these techniques evolved from deep lamellar endothelial keratoplasty (DLEK) to Descemet's stripping endothelial keratoplasty (DSEK) to DMEK, as the layers of host tissue that were removed and the layers of donor tissue that were implanted became increasingly selective (*Figure 1*).<sup>1,2</sup> The current two EK techniques in wide-

spread use—DMEK and DSEK—have led to faster visual recovery, better vision outcomes and substantially lower risk of complications.

The primary difference between DMEK and DSEK is that the former consists of healthy donor endothelium and Descemet's membrane, whereas DSEK also includes some posterior stromal tissue (*Figure 1*). Key advantages of the DMEK procedure are that it provides faster visual recovery and has lower risk of immunologic rejection, whereas the thicker DSEK donor tissue tends to adhere more readily to the host cornea and is easier for the surgeon to manipulate. As reported in the *Journal of Eye Banking and Corneal Transplantation*, DMEK and DSEK comprised nine out of 10 grafts performed for endothelial disease in 2022, while penetrating keratoplasty (PK) accounted for only one out of 10.<sup>3</sup> It is therefore important for eyecare professionals to understand these techniques and how to manage pre- and postoperative care.

### About the authors

**Dr. Kelley** practices at Price Vision Group in Indianapolis, IN, and is experienced in caring for complicated corneal transplant patients and laser refractive surgery patients. She has served as a sub-investigator in numerous clinical trials and coordinated the clinical studies on artificial irises and the intraocular lenses for high levels of nearsightedness. **Dr. Francis Price, Jr.**, is founder and president of Price Vision Group and the Cornea Research Foundation of America. He is also the president and co-founder of the Medical Practice Consortium, a nonprofit organization providing health insurance benefits to 90 independent group medical practices who are members of the Indiana State Medical Association. He has authored over 250 peer-reviewed publications and book chapters and been principal investigator of more than 130 clinical studies of ophthalmic devices, medications and surgical techniques. **Dr. Marianne Price** is executive director of the Cornea Research Foundation of America in Indianapolis, IN. She holds a PhD in Medical and Molecular Genetics from Indiana University School of Medicine. Dr. Price has authored over 150 peer-reviewed publications and book chapters and made presentations to vision care audiences around the world. They have no financial disclosures.



**Fig. 1. Schematic illustrating the relative thickness and layers of recipient tissue removed and donor tissue implanted in successive iterations of EK known as DLEK, DSEK and DMEK. Note that DLEK includes removal of recipient posterior stroma, Descemet's membrane and endothelium whereas only the central host Descemet's membrane and endothelium are removed in DSEK and DMEK.**

The most important preoperative consideration is that early intervention with EK is associated with better visual outcomes, because, over time, corneal edema leads to stromal and epithelial fibrosis. The epithelium can be removed during EK to treat map-dot-fingerprint or anterior basement membrane dystrophy, but the stromal tissue is not replaced, so any stromal fibrosis will adversely affect postoperative vision.<sup>4</sup> Overall, EK is a small-incision procedure with an excellent safety profile; the benefits of early intervention typically outweigh the risks.

### **Fuchs' Dystrophy: Clinical Considerations**

As mentioned previously, Fuchs' endothelial corneal dystrophy (FECD) is the leading indication for EK in the United States, followed by corneal edema after cataract surgery.<sup>3</sup>

One of the first symptoms patients notice is glare from the guttae (Figure 2). Even those who can see relatively well on a standard eye chart in a darkened room often experience glare that interferes with activities of daily living, such as driving at night, working under fluorescent lights or being outdoors on a bright, sunny day. Corneal edema and lens changes can also contribute to glare, but we can't overlook the

contribution of the guttae. In addition to a careful assessment of symptoms, a brightness acuity test is a useful tool in determining the level of glare in early FECD. Ask about their level of confidence in driving at night. Have they encountered difficulties or stopped driving at night all together? Is their spouse afraid to ride in a car with them if they are driving?

As FECD progresses, corneal endothelial cells loss continues. Eventually, the remaining cells become unable to maintain optimal corneal hydration, resulting in stromal edema, which disrupts the stromal collagen spacing. This increases light scattering and leads to clinical complaints of blurry vision, especially in the morning. Pachymetry should be used to monitor corneal thickness changes. As edema becomes more significant, thickness will increase and the patient can have painful bullae and scarring occur. With the rapid vision recovery that comes with EK procedures, reduction in glare and improvement in color vision, eyecare providers should consider referring patients early for surgical intervention.

Patients with visually significant Fuchs' dystrophy often have cataracts as well. Most prefer to have the cataract surgery and Fuchs' treatment at the same time instead of undergoing

separate surgical procedures. EK can be performed simultaneously with cataract surgery, using the same main incision for the DMEK procedure or enlarging it slightly for DSEK. However, corneal guttae and edema affect the imaging used to determine the optimal intraocular lens power, so refractive outcomes are less predictable when cataract surgery is combined with EK than they are when cataract surgery is performed alone in eyes with normal corneas. While there is an average shift towards hyperopia (about 0.5D) after EK because of posterior corneal curvature steepening associated with resolution of edema, either a myopic or hyperopic shift can occur from what was predicted (range -2.00D to +3.00D). Methods to optimize refractive outcomes are later discussed in the Visual Outcomes section.

### **Additional Indications**

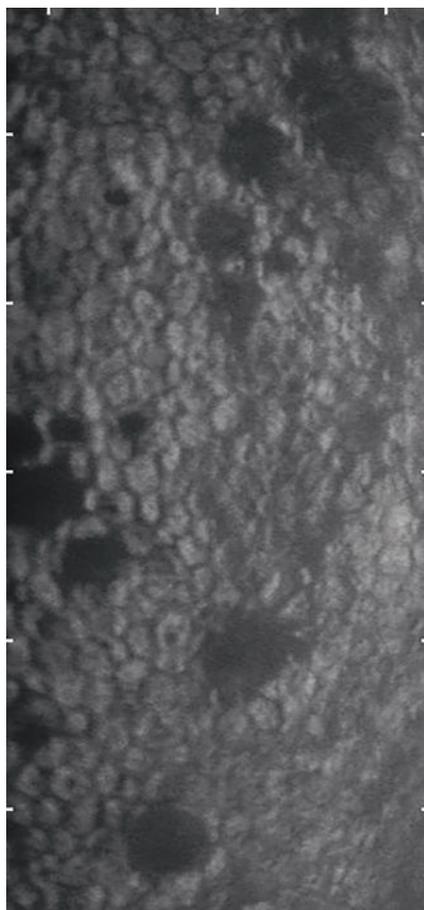
The other leading indications for EK are bullous keratopathy and failed previous keratoplasty.<sup>3</sup> Each year approximately four million cataract procedures are performed in the US, and about 4,000 keratoplasty procedures are performed to treat corneal edema following cataract surgery. An increasing cause of endothelial failure is secondary corneal edema after glaucoma filtration

### **EK Surgery at a Glance**

The key elements of EK surgery are:

- Removal of 8mm diameter of dysfunctional host endothelium and Descemet's membrane.
- Insertion of curled or folded donor tissue with healthy endothelium through a small incision.
- Unfolding and positioning of the donor tissue against the host cornea (Figure 3).
- Injection of an air or gas bubble to hold the donor tissue in place (in lieu of sutures).

The air bubble naturally dissipates over several days. Some surgeons prefer to use a gas mixture that remains in the eye longer.



**Fig. 2. Specular microscopy image of the corneal endothelium in a patient with early Fuchs' dystrophy. The dark areas are the characteristic guttae associated with endothelial cell drop out.**

surgery, especially tube shunts. Among the approximately 50,000 keratoplasty procedures performed each year in the US, over 10% are regrafts, primarily to treat endothelial decompensation.<sup>3</sup>

Less common conditions that can be treated with EK include post-infectious endothelial dysfunction, iridocorneal endothelial syndrome, polymorphous corneal dystrophy and congenital hereditary endothelial dystrophy. EK can be performed in eyes with challenging anterior chamber anatomy (*e.g.*, glaucoma tube shunts, aniridia and aphakia) with appropriate modifications. Surgeons often prefer DSEK over DMEK in unicameral eyes because the thicker DSEK tissue can be suture fixated to the host cornea to prevent migration into the posterior chamber.

### Post-Surgical Care

Clinically, there are four things to watch for after EK surgery: pupillary block, graft detachment, steroid-induced intraocular pressure (IOP) rise and immunologic graft rejection. Surgeons often create an inferior peripheral iridotomy to prevent pupillary block and leave a large air bubble in the eye at the end of the case. Before sending the patient home after surgery, examine the eye at the slit lamp to ensure the peripheral iridotomy is patent and the IOP is within the normal range.

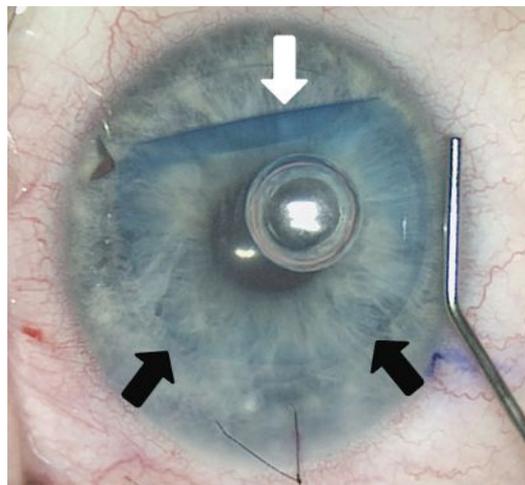
Edge detachment is the most common early postoperative complication (*Figure 4*). A DSEK graft includes posterior donor stromal tissue, which tends to adhere more readily to the host cornea than a DMEK graft. Corneal surgeons typically follow EK patients closely in the first week to assess attachment, and they may ask patients to lay on their back as much as possible for the first day or so—particularly after DMEK—to allow the bubble to press the graft against the host cornea.

If over one-third of the graft is detached, an area of detachment seems to be increasing or detachment extends into the visual area, the surgeon can reinject air or gas into the eye to promote attachment. Re-bubble rates commonly vary from 5% to 25%, depending upon specific techniques used, as well as donor and host factors.<sup>5</sup> Patients may return to the optometrist's care with small edge detachments that just need to be monitored. These will resolve over time, but if the area of detachment appears to be increasing or affecting vision, referral back to the surgeon is warranted.

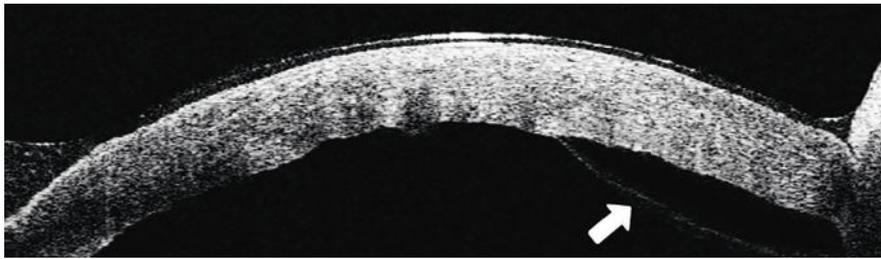
Topical corticosteroids are used after EK to prevent graft rejection, with the dosage and tapering schedule varying among corneal surgeons. The most common side effect of prolonged topical steroid use

is IOP rise (patients with pre-existing glaucoma are particularly susceptible). Monitor pressures closely, especially in the first three to six months post-surgery due to higher initial steroid dosing, which is tapered over time. Prospective, randomized studies have shown that the topical steroid strength can be safely reduced one month after EK or two months after EK combined with cataract surgery, from prednisolone acetate 1% to fluorometholone 0.01% or loteprednol 0.5%.<sup>6,7</sup> This early steroid reduction substantially reduces the risk of IOP elevation. Patients that remain on steroids of any dose should be followed at least every six months to monitor IOP.

An advantage to EK is that episodes of rejection are significantly less than with PK. One study reported rejection rates of 1.7% with DMEK, 5% with DSEK and 14% with PK in a five-year study in grafts that were performed for FECD and bullous keratopathy.<sup>8</sup> Preventing immunologic graft rejection is the reason behind keeping keratoplasty patients on topical steroids long-term.



**Fig. 3. This intraoperative image shows placement of DMEK donor tissue in a recipient eye. The DMEK tissue, which is approximately 20µm thick, was stained with trypan to facilitate visualization. The tissue was folded for insertion through a 2.2mm incision, and is being uncurled inside the eye using tapping maneuvers on the surface of the host cornea. A small air bubble was injected beneath the DMEK tissue to help it stay uncurled and pressed against the host cornea. The black arrows show the thin edge of the graft where it is fully uncurled and the white arrow shows an edge that is still curled.**



**Fig. 4. Anterior segment OCT showing partial DMEK detachment (indicated by the arrow).**

Rejections in EK patients, especially DMEK, can be subtler than in PK eyes. Increase in pachymetry in the absence of any other signs is an indicator of rejection and should be treated with increased topical steroids. Less common signs of rejection in EK include redness, pain, increased stromal haze and keratic precipitates. Knowing your surgeon's protocol for steroid use is important for the long-term care of EK patients.

### Visual Outcomes

EK provides rapid visual rehabilitation and excellent long-term visual outcomes. With DMEK, about 70% of patients achieve 20/25 or better best-corrected visual acuity (BCVA) within three months and over half have 20/20 or better BCVA at five years and 10 years in the absence of other vision-limiting ocular co-morbidity. The median BCVA tends to be about one line less with DSEK because DSEK tissue is slightly thicker and more likely to increase higher order aberrations on the posterior corneal surface.<sup>5</sup> EK has also been shown to improve color vision and discernment.<sup>9</sup>

Given these impressive BCVA outcomes, FECD patients are increasingly interested in optimizing uncorrected visual acuity (UCVA) with EK and concurrent or staged cataract surgery. The challenge is that the corneal changes associated with FECD distort the biometry measurements used to determine the optimal intraocular lens power, so it is harder to hit the refractive target and optimize UCVA in FECD patients.

Two approaches can be taken to optimize UCVA in FECD patients. The first is to combine DMEK with cataract surgery and implant an intraocular

lens that can be adjusted postoperatively. In our study of this approach, we found that 90% of the treated eyes achieved UCVA of 20/25 or better and 100% had UCVA of 20/40 or better.<sup>10</sup> Another way to optimize UCVA is to perform DMEK, allow the cornea to stabilize, do the biometry measurements and then perform cataract surgery. This approach allows implantation of a presbyopia-correcting intraocular lens in patients who want to minimize the need for glasses.

Two types of presbyopia-correcting lenses are approved in the US: extended depth of focus and multifocal. The latter design provides better near vision but is associated with more visual phenomena, such as glare and halos, so some surgeons avoid multifocal lenses in Fuchs' dystrophy eyes. We found that DMEK followed later by cataract surgery and implantation of a presbyopia-correcting lens resulted in median BCVA of 20/20 (range 20/15 to 20/25), median binocular UCVA of 20/25 (range 20/15 to 20/25) and median binocular uncorrected near vision of 20/20 (range 20/20 to 20/50).<sup>11</sup>

### Graft Survival

Long-term EK survival equals or exceeds that PK when performed by experienced surgeons, although the EK learning curve is associated with increased risk of early graft failure. In large, prospective, multi-center US clinical studies with experienced surgeons, the graft success rate at three years was 94% with DSEK and 92% with PK for treatment of similar indications.<sup>12</sup> Five-year survival rates of DMEK and DSEK performed for FECD at two large referral centers ranged from 93% to 97%.<sup>8,13</sup>

The principal patient characteristics that influence EK survival are the indication for grafting and prior glaucoma filtration surgery. Patients with relatively functional peripheral corneal endothelium, such as FECD patients, generally have better long-term graft survival than those with dysfunctional peripheral endothelium, such as patients with pseudophakic or aphakic corneal edema. Pre-existing medically managed glaucoma moderately increases the risk of graft failure. Prior glaucoma filtration surgery, including trabeculectomy or aqueous tube shunt, substantially increases the risk of failure such that those patients should be advised that their graft may need to be replaced within five years.<sup>14</sup> Fortunately, it is straightforward to remove a failed EK and replace it through a small incision.

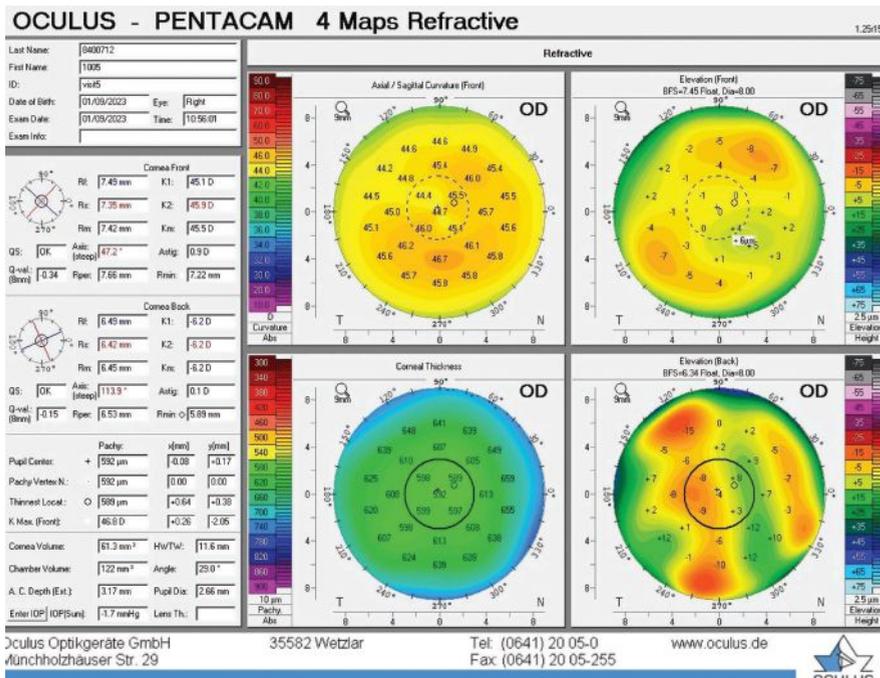
### New Treatments on the Horizon

Currently, EK is the gold standard for treating corneal endothelial dysfunction, as it safely provides rapid visual rehabilitation and has excellent long-term outcomes. The US harvests an adequate supply of donor tissue to meet domestic needs, but most other countries in the world do not. Therefore, alternative approaches that could help address the worldwide shortage of donor tissue are being evaluated in US clinical trials. These include a surgical technique called Descemet's stripping only (DSO), injection of cultured human corneal endothelial cells and pharmacologic or biologic eye drop treatments.

In patients with FECD, the deposition of guttae and endothelial cell dropout often begin centrally, and some patients with symptomatic FECD still have healthy peripheral corneal endothelium. DSO removes central Descemet's membrane and endothelium without implanting any

Scan the QR code at right to watch a video of DMEK combined with cataract surgery.





**Pentacam image of posterior corneal irregularities and displacement of thinnest point in Fuchs' dystrophy.**

donor tissue. It can be used in selected patients with early-stage FECD who still have healthy peripheral endothelium that can migrate over and cover the denuded area. The clearing rate varies substantially between patients, and we do not yet have a way to predict who will be a rapid responder, a slow responder or a non-responder.

Studies have shown that the likelihood of successful clearing improves if the area of stripping is limited to 4.5mm or less (this is only 25% as much area as is removed with EK).<sup>15</sup> Early-stage clinical trials have shown that two approaches—either injection of a growth factor at the time of DSO or use of a rho-kinase inhibitor eye drop for several months post-op—can help with corneal clearing.<sup>16</sup> Studies suggest that ripasudil, a rho-kinase inhibitor approved in Japan for treatment of glaucoma, may be more effective after DSO than netarsudil, the rho-kinase inhibitor approved in the US for that purpose. Ripasudil is currently being evaluated in US clinical trials for use with DSO (NCT05795699 and NCT05826353 on ClinicalTrials.gov).

Compared with EK, the main advantages of DSO are that it does not

require donor tissue or long-term use of topical corticosteroids to prevent rejection. Main disadvantages are that it's limited to early-stage FECD patients and visual rehabilitation tends to be slower and less predictable. Approximately one in 10 eyes do not fully clear after DSO and require rescue with EK.

Human corneal endothelial cells can be expanded in the laboratory, allowing cells derived from a single donor cornea to be used to treat 100 or potentially up to 1,000 patients.<sup>17</sup> Several companies are conducting clinical trials in the US to evaluate cell injection therapy.

Clinical trials are underway to evaluate eye drop treatments that could potentially slow or halt the progression of FECD. Treatments that target the most common genetic marker in FECD, a trinucleotide repeat expansion in the TCF4 gene, are also in development. While DSO costs substantially less than EK because it does not require any donor tissue, we don't know yet how the cost of cell injection therapy, pharmacologic or genetic treatments will compare with EK, which for most patients is a one-time treatment that provides excellent visual rehabilitation.

**Takeaways**

In conclusion, whenever patients ask whether they should undergo EK or wait for new treatment options to become available, we ask whether visual problems have started to impact or restrict daily activities, such as driving at night, reading or athletic pursuits. If so, we advise them to proceed with EK because it will quickly restore vision and allow them to resume their lifestyle. ■

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# CORNEAL PAIN PRESENTATIONS: CAUSES AND INTERVENTIONS

Get up to speed on the basis and manifestations of neuropathic as well as neurotrophic changes.



BY DANIEL GRANGAARD,  
OD, WILLIAM HILEMAN, OD,  
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The cornea is the most powerful pain generator in the body, with an estimated 7,000 nerve terminals per millimeter.<sup>1,2</sup> It is 300- to 600-times more sensitive than human skin and provides sensory information that helps relay touch, chemical, pain and temperature signals.<sup>1</sup> Its ability to register these signals helps induce tear production, blinking and release of trophic factors to maintain structural integrity.

The nasociliary nerve bundles that innervate the cornea enter the limbus in a radial pattern, then migrate anteriorly to penetrate Bowman's layer and rest under the basal epithelial layer to form the sub-basal nerve plexus.<sup>2,3</sup> These nerves then rise to superficial intra-epithelial terminals, which terminate as bulbous free nerve endings that have nociceptors for sensing pain.<sup>2,3</sup> If the corneal nerves are damaged due to injury or disease, the healing process

can lead to abnormal regeneration and changes in the regulation of pain receptors. These regulatory changes in the pain receptors may cause either an increase or decrease in pain perception by patients when exposed to stimuli.

Corneal neuropathic pain, typically a diagnosis of exclusion, describes a heightened perception of pain in the absence of painful stimuli.<sup>1</sup> Patients may experience a variety of symptoms such as burning, irritation, dryness, grittiness and most importantly photophobia, which is a pain sensation in response to light.<sup>1</sup> Neuropathic pain may present without any visible findings during an exam, making it extremely hard to diagnose, especially when patients express severe pain symptoms. This condition may also be referred to as "pain without stain" or phantom cornea.<sup>1</sup>

By contrast, corneal neurotrophic changes are characterized by a reduction or lack of corneal sensitivity due to impairment of corneal innervation. In this case, the corneal findings are significant and there are little to no symptoms.

## Patient Workup

The subjective nature of pain makes clinical assessment challenging, particularly when there is a mismatch between signs and symptoms.

How do you measure corneal pain? Although ocular pain can be a common reason for someone to seek medical attention, it is not always easy for patients to quantify and describe. There are several ophthalmic patient survey instruments available, but most emphasize symptoms of dry eye syndrome rather than ocular pain. So, in 2010, the National Eye Institute workgroup on ocular pain and sensitivity identified a need for a reliable and validated way to assess, measure and quantify ocular pain.<sup>4</sup> This led to the creation of the Ocular Pain Assessment Survey (OPAS; *Figure 1*), which has been validated as a reliable way to quantify not only general ocular pain but also corneal pain.<sup>4</sup>

The OPAS is a quantitative questionnaire that assesses pain in the past 24 hours and past two weeks by having patients answer questions related to

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**Fig. 1. The OPAS has a series of questions to gather patient feedback on symptoms related to both ocular pain and corneal pain.<sup>4</sup>**

pain intensity, quality of life changes, frequency of pain, aggravating factors, associated factors and symptom relief.<sup>4</sup> It is a survey that can be easily administered by both non-clinical and clinical staff as patients complete their treatment plans to determine if their quality of life has improved.

How do you evaluate for corneal pain and sensitivity? Corneal esthesiometry

is a tool for measurement of corneal sensation that can be used to detect an underlying neurotrophic component to a patient's symptoms. These tests may be contact or non-contact and must be performed before using an topical anesthetic.

One of the most common methods is using the Cochet-Bonnet (*Figure 2*), a handheld device that contains a thin,

retractable nylon filament and can extend up to 6cm.<sup>5</sup> During this test, it is necessary to document the length when a patient first feels contact, as a shorter length indicates a decrease in corneal sensitivity.<sup>5</sup> It can be used to test various discrete regions of the cornea (e.g., central, superior, inferior).

Other test options now include the Corneal Esthesiometer Brill (CEB), which is a recently FDA-approved non-contact method to test corneal sensitivity.<sup>5</sup> It can either be used as a handheld device or mounted to the slit lamp and has a camera with two infrared LEDs to ensure a correct testing distance and positioning of the device.<sup>5</sup> It works by stimulating the cornea at different pulsed pressures using air at ascending gradients until the patient reports feeling the air.<sup>5</sup> This can then be quantified on a grading scale of 1 through 5, with grade 1 indicating corneal hypersensitivity, grades 2 and 3 regular corneal hypersensitivity and grades 4 and 5 corneal hyposensitivity.<sup>5</sup> This grading scale allows clinicians to monitor for changes in sensitivity in a simple and objective way.

Additionally, clinicians must distinguish between central and peripheral pain, which can be done with topical

### Corneal Pain Presentations: Causes and Interventions

Jointly provided by Postgraduate Institute for Medicine (PIM) and Review Education Group

**Release Date:** April 15, 2024

**Expiration Date:** April 15, 2027

**Estimated Time to Complete Activity:** two hours

**Target Audience:** This activity is intended for optometrists interested in understanding and treating corneal neurotrophic changes and/or neuropathic pain.

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

- Effectively distinguish between corneal pain presentations.
- Accurately assess corneal pain in clinical practice.
- Recognize the various causes of corneal pain and sensitivity.
- Determine the best course of treatment for patients presenting with corneal pain.

**Faculty:** Daniel Grangaard, OD, William Hileman, OD, and Steve Njeru, OD

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**Fig. 2.** With a Cochet-Bonnet esthesiometer, you are able to see the markings on the side that reflect the maximum 6cm length of the nylon filament.<sup>5</sup>

proparacaine on the cornea. Typically, proparacaine helps relieve peripheral nerve pain without any effect on central pain.<sup>1</sup> Therefore, if a patient experiences complete relief with topical 0.5% proparacaine hydrochloride, then they are most likely experiencing only peripheral corneal pain.<sup>1</sup> If there is partial relief, then they are most likely experiencing a mixed form of central and peripheral corneal pain.<sup>1</sup> However, if there is no relief or the symptoms worsen, then they are most likely experiencing only central corneal pain.<sup>1</sup>

### Common Causes

There are many conditions that can alter corneal sensory responses and many differential diagnoses to consider.

**Dry eye disease.** Tear film stability is an essential factor in maintaining corneal integrity. Dry eye is a multifactorial disease characterized by the loss of tear film homeostasis and development of ocular surface inflammation.<sup>6</sup> Common symptoms include burning, stinging, blurred vision and a gritty/sandy sensation.

Mild to moderate ocular findings can be subtle and include persistent conjunctival injection, intermittent blurred vision from an unstable tear film, reduced tear break-up time and excessive reflex tearing due to irritation from dryness. In moderate to severe forms of dry eye, persistent surface inflammation can result in corneal abnormalities such as epithelial keratitis, and, in more severe cases, it can lead to persistent epithelial defects and even corneal ulcers from neurotrophic changes.<sup>6</sup>

A complicating factor is that patients may present with symptoms that do not match the clinical findings as corneal nerve damage occurs from chronic surface inflammation. Chronic dry eye disease has been shown to change corneal sensitivity and lead to a loss in sub-basal corneal nerve density.<sup>6</sup> As such, dry eye disease needs to be considered as a contributing factor to both neurotrophic changes and neuropathic pain symptoms.

**Recurrent corneal erosion (RCE).** This condition causes acute symptoms of pain, tearing, photophobia and blurred vision. The estimated incidence suggests 25.4 cases per 100,000 annually.<sup>7</sup> In the acute phase, symptoms are generally secondary to an epithelial defect that can form on any area of the cornea.<sup>8</sup> RCEs occur due to a dysfunction of the epithelial cells and the basement membrane complex.

The initial cause of RCE may come from trauma such as corneal abrasion, dystrophies such as epithelial basement membrane dystrophy or even previous corneal infections.<sup>8</sup> The painful symptoms experienced by patients are commonly short-lived; however, due to their recurrent nature, patients can repeatedly experience symptoms of pain, burning and blurred vision.<sup>8</sup> RCE can have a significant impact on the cornea as it disrupts the healing process, which can cause an upregulation of pain receptors and lead to neuropathic pain.

**Surgery.** Refractive surgeries—LASIK in particular—are among the most commonly performed surgical procedures in the United States.<sup>9</sup>

Following LASIK, all patients will experience corneal pain to some extent and there will be potential for a temporary neurotrophic state until the nerve plexus regenerates due to the transection of corneal nerves and loss of superficial innervation following the flap creation. However, some patients can experience symptoms of ocular surface disease as a complication long after the postoperative healing process. Patients with persistent symptoms following LASIK experience pain, spontaneous burning, light sensitivity, sensitivity to air and soreness or aching around the eye.<sup>9</sup> These symptoms occur without any significant clinical findings, and patients will often have a limited response to conventional therapies.

The prevalence of neuropathic corneal pain following LASIK is unknown but is estimated to be about one out of 900 patients.<sup>9</sup> Many risk factors have been identified, ranging from psychiatric conditions such as depression and anxiety to autoimmune conditions like fibromyalgia and thyroid eye disease.<sup>9</sup> A multimodal treatment regimen is recommended for patients with neuropathic pain following LASIK. Treatment options include artificial tears, anti-inflammatory agents, amniotic membranes and, in rare cases, oral pain medication.

**Chemical burn.** Corneal injury resulting in epithelial and corneal nerve density damage is often another etiological factor leading to the development of neuropathic pain. Chemical or thermal burns cause damage to the integrity of corneal innervation and can result in impaired corneal wound healing and prolonged epithelial defects (*Figure 3*).<sup>10</sup>

The severity of corneal injury is dependent on the pH of the offending chemical substance. Acidic chemicals denature and coagulate corneal proteins, creating a barrier that prevents penetration into deeper structures.<sup>10</sup> Conversely, alkali chemicals are lipophilic and will penetrate deeper structures, causing much more significant ocular trauma.<sup>10</sup> Alkali burns are more likely to lead to neuropathic pain,

as alkali chemicals have a higher rate of penetration than acids.<sup>10</sup> Common symptoms include pain, redness, blurred vision and foreign body sensation.

Patients suffering from a chemical burn require emergent irrigation until the ocular surface pH has normalized between 7.0 and 7.2 and will require further treatment with antibiotics, steroids or amniotic membranes.<sup>10</sup> Patients who experience chemical or thermal injury should be observed frequently with the existing risk of developing neuropathic pain.

**Keratitis.** Herpetic eye disease (both simplex and zoster) is a leading cause of neurotrophic keratitis. The herpes simplex virus (HSV) has two subtypes: HSV-1 and HSV-2. The former typically affects the oral, labial and ocular regions.<sup>11</sup> HSV-1 will stay latent in the dorsal root ganglion of the trigeminal nerve.<sup>11</sup> During reactivation, it travels back to the cornea via the ophthalmic branch of the trigeminal nerve and presents as epithelial, stromal or endothelial keratitis.<sup>11</sup> Generally, reactivation can be triggered by fever, hormonal changes, UV exposure, stress, surgeries or trauma.<sup>11</sup> The global annual rate of new herpes keratitis cases is about 1.5 million, with an estimated 40,000 new cases of severe visual impairment or blindness each year secondary to HSV-1.<sup>11</sup>

Herpes simplex epithelial keratitis is the most common area of corneal involvement and is responsible for 50% to 80% of ocular herpes infections.<sup>12</sup> Within 12 to 24 hours, the infected epithelial cells will form punctate vesicles that are caused by swollen cell nuclei filled with replication DNA viral load, which begins the first stages of a dendrite.<sup>13</sup> Next, these infected cells will start to swell, burst and shed the virus, infecting nearby cells and causing the appearance of a dendrite. These dendrites will appear as superficial and branch out in a linear pattern with terminal bulbs that have raised edges (*Figure 4*).<sup>13</sup> Topical dyes such as fluorescein will stain the whole body of the dendrite and improve visibility

of the ulcer bed, whereas rose bengal or lissamine green will only stain the terminal bulbs at the margins of the dendrite due to the devitalization of the cells.<sup>13</sup>

Unfortunately, herpes simplex can affect all layers of the cornea, including the stroma and endothelium during initial infections and/or phases of reactivations due to an inflammatory response from HSV antigens. Herpes simplex can lead to both neurotrophic changes and/or neuropathic pain since it alters corneal sensitivity by either decreasing or increasing sensitivity to stimuli, depending on the severity and/or location of the infection.

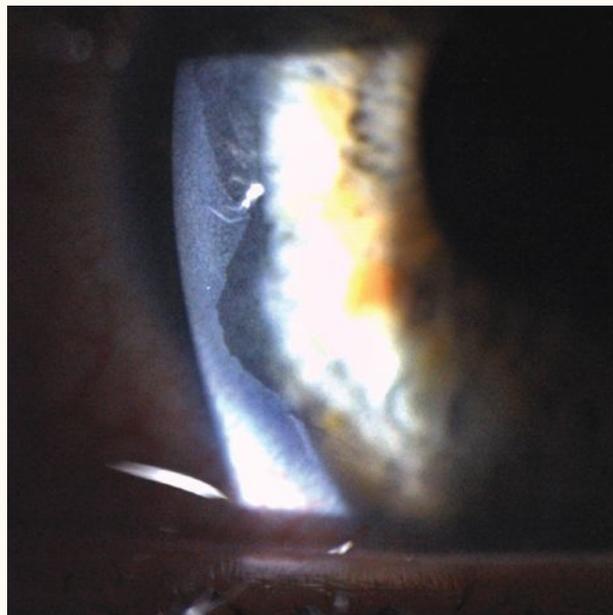
The varicella-zoster virus can first manifest as chickenpox during childhood as the primary infection, and then as herpes shingles during a reactivation phase. The primary infection is a result of direct contact with an infected individual who has an itchy vesicular rash across their body.<sup>14</sup> Herpes shingles is secondary to the dormant virus that has established latency within the dorsal root ganglion of the nerve; roughly 20% to 30% of infected individuals will have this latency broken, and the virus will present as a painful vesicular rash on the skin that respects the dermatome.<sup>14</sup> This reactivation phase is most commonly caused by an immune stress, which can often be seen in advanced aging or illness.<sup>14</sup>

When there is ocular involvement, it is called herpes zoster ophthalmicus, which accounts for roughly 10% to 20% of zoster cases, and can cause significant damage to the cornea (*Figure 5*).<sup>14</sup> The most commonly involved structure is the cornea with herpes zoster keratitis occurring in up to 65% of cases with various manifestations

that involve the epithelium, stroma and endothelium.<sup>15</sup> Pseudodendrites are a common ocular finding and can appear in 50% to 75% of cases.<sup>15</sup> Unlike true dendrites from HSV keratitis, pseudodendrites do not have terminal end bulbs and lack ulceration, so the lesions appear flat.

When treating herpes zoster, optometrists should also be aware of the risk that patients may develop postherpetic neuralgia. This is a neuropathic pain syndrome that can persist or develop even after the rash has resolved with successful treatment. Treating herpes zoster within at least 72 hours will reduce the risk of developing postherpetic neuralgia but unfortunately will not completely prevent it from occurring.<sup>14</sup> It is important to be aware of this syndrome, as it can cause debilitating pain and increase the risk of suicide from emotional distress.<sup>15</sup>

Bacterial infection is another common cause of infiltrative keratitis, with a major factor being contact lens use. The risk for infection with contact lens wear increases with overnight wear, poor case hygiene or storage, inadequate lens disinfection and poor hand washing prior to insertion and



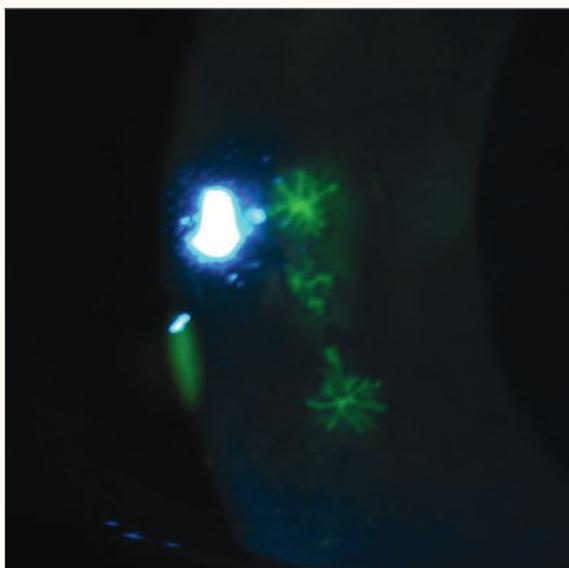
**Fig. 3.** This patient had a severe chemical burn secondary to exposure from a basic commercial water treatment product. This led to significant epithelial loss that can be seen at the temporal aspect of the cornea near the limbus.

removal.<sup>16</sup> Roughly 80% of bacterial keratitis cases are caused by *Staphylococcus*, *Streptococcus* and *Pseudomonas* species, but clinicians should also be wary of other causes such as *Neisseria*, *Haemophilus*, *Corynebacterium diphtheriae*, *Neisseria meningitidis* and *Listeria* as these species of bacteria can penetrate an intact corneal epithelium.<sup>16</sup>

The presentation for bacterial keratitis may vary based on the organism, but most patients will present with blurred vision, pain, redness, discharge and/or photophobia.<sup>16</sup> These symptoms will often coincide with the presence of a corneal ulcer secondary to a loss of epithelial tissue at the site of infection (Figure 6). This will then lead to a stromal infiltration of white blood cells such as polymorphonuclear and lymphomononuclear cells, which can lead to the destruction of Bowman's layer and also stromal necrosis if the infection is left untreated.<sup>16</sup> As the cornea tries to regenerate the epithelium, increase vascularization and remodel the stroma, this can ultimately lead to future neurotrophic changes as aberrant nerve regeneration may occur.

**Drug toxicity.** When prescribing any topical medication, patients must be provided with a thorough review of possible adverse reactions. These are an unintended or undesired effect of the drug that may occur from regular use of the medications, misuse of medications or overdose. There are many topical medications that can cause corneal toxicity.

Topical antibiotics such as tobramycin or gentamycin are effective methods for treating bacterial conjunctivitis or corneal infections, but they have a common side effect of causing significant superficial punctate lesions to form, which can lead to discomfort and/or irritation.<sup>17</sup> Topical anti-inflammatory medications such as NSAIDs or steroids can also cause issues with corneal epithelial wound healing and re-epithelization, especially when used together.<sup>17</sup> Topical anesthetics, which



**Fig. 4.** This patient was diagnosed with acute herpes simplex keratitis, as these three elevated dendrites were stained with fluorescein.

are routinely used during exams, have been known to inhibit epithelial migration and destroy the superficial corneal epithelial microvilli.<sup>17</sup> This can lead to loose epithelial cells and cause irritation amongst patients. Additionally, the preservatives in many over-the-counter drops such as artificial tears can cause damage to the epithelial cell; chlorobutanol and benzalkonium chloride are common culprits.<sup>17</sup>

These are just a few examples of corneal toxicity related to topical medications. Clinicians should be aware of the general side effects and the potential sequelae if there is corneal damage secondary to chronic or even abuse of a topical medication. Drug toxicity from routinely prescribed ocular medications can lead to neurotrophic changes and/or neuropathic pain, as damage to the corneal nerves from long term use of topical medications will affect corneal sensitivity.

**Systemic disease.** Diabetic neuropathy is a common complication of diabetes because of microvascular alterations.<sup>18,19</sup> Many areas of the body can be affected—including the eye. Although we most frequently discuss the effects of diabetes on the posterior segment, specifically the retina, diabetes also impacts the anterior segment of the eye,

including the cornea, conjunctiva and lacrimal glands.

Diabetes-induced corneal neuropathy is a common but underdiagnosed ocular complication of diabetes mellitus. Around 46% to 64% of patients develop diabetic neuropathic keratopathy throughout the clinical course of diabetes mellitus.<sup>18,19</sup> The basic pathophysiology of diabetic corneal neuropathy is due to chronic hyperglycemia causing microvascular changes.<sup>18</sup> These changes lead to local ischemia and poor nutrient delivery, resulting in progressive damage to the corneal nerves. Another factor is the inability of the damaged corneal nerves to secrete the neuromediators that help maintain ocular surface homeostasis.<sup>18</sup>

Early cases of diabetic corneal neuropathy may present as punctate epithelial erosions and tear film abnormalities.<sup>18,19</sup> Moderate cases involve larger epithelial defects, RCEs and poor corneal wound healing.<sup>18,19</sup> The most severe cases involve larger non-healing neurotrophic ulcers caused by reduced corneal sensation and potential corneal melt.<sup>18,19</sup> These more moderate and severe cases will be reflective of neurotrophic changes, as the corneal findings are more significant because of decreased corneal sensitivity. Therefore, it is imperative to consider diabetes in cases of both neurotrophic changes and neuropathic pain as the condition becomes more prevalent in the United States.

Trigeminal neuralgia is a sensory condition characterized by pain along one of the three branches of the nerve, characterized by an electric shock-like pain triggered by normally benign stimuli.<sup>20</sup> It is the most common facial pain syndrome, with an annual incidence of four to 13 per 100,000.<sup>20</sup> The ophthalmic branch (V1) innervates the scalp, upper eyelids, and cornea. Although the condition may be idiopathic, it is often caused by neurovascular compression. Isolated V1 trigeminal neuralgia occurs in 3% of patients.<sup>20</sup>

Ophthalmic manifestations include photophobia, lacrimation, excessive blinking and hyperemia.<sup>20</sup>

Fibromyalgia is a chronic systemic disorder characterized by widespread musculoskeletal pain, fatigue, sleep disturbances, headaches and cognitive issues.<sup>21</sup> Most recently, it has been recognized as a neuropathic pain syndrome. Decreased small nerve fiber density has been found in patients with fibromyalgia in recent studies.<sup>21</sup> The cornea has been found to have thinner stromal nerves and decreased sub-basal cell plexus nerve density when viewed with *in vivo* corneal microscopy in women with fibromyalgia.<sup>21</sup> These nerve plexus changes have been associated with neuropathic pain. Anterior segment ocular features include severe pain and a higher incidence of dry eye syndrome.<sup>22</sup>

## Treatments

Efforts to normalize corneal sensitivity will necessarily be tailored to the inciting condition or episode.

**Neuroregenerative.** Cenegermin 0.002% ophthalmic solution (Oxervate, Dompé) was approved by the FDA in 2018 for the treatment of moderate to severe neurotrophic keratitis.<sup>23</sup> Cenegermin

is a recombinant human nerve growth factor that has been shown to support corneal integrity through multiple mechanisms, including stimulating epithelial cell growth, limbal epithelial stem cell viability and the promotion of tear production via binding receptors on the lacrimal gland.<sup>23</sup>

Cenegermin has been studied in multiple clinical trials. Its efficacy in treating neurotrophic persistent epithelial defects compared to a vehicle sham over the course of eight weeks showed significantly improved reductions in lesion size.<sup>24</sup> In achieving complete reduction of epithelial defects, cenegermin outperformed the vehicle sham at both the halfway point (four weeks) and eight-week endpoint.<sup>24</sup> Cenegermin is a preservative-free ophthalmic solution dosed six times a day at two-hour intervals for eight weeks.<sup>23</sup> While clinically effective, the dosing schedule and cost may be barriers to some patients.

Autologous serum tears, first reported in 1975 for treating tear deficiency in those with ocular surface disease and can successfully improve types related to systemic disease, ocular pathology and postoperative patients.<sup>25</sup> Unlike artificial tears, blood-derived eye drops contain growth factors, platelets and proteins

to help prevent cell death, improve cell growth, migration and promote healing.<sup>25</sup>

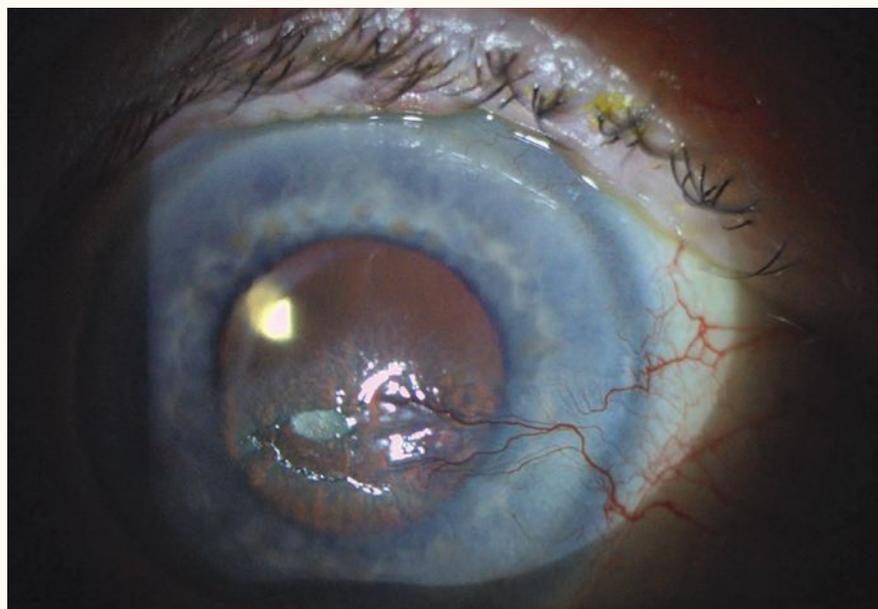
There are several scenarios where blood-derived drops such as serum tears, are useful, especially in cases of severe dry eye after maximum topical treatment, postsurgical complications with delayed healing, chronic epithelial defects and corneal neurotrophic pain. These serum tears can be written as a prescription to a compounding pharmacy and can be tailored to the patient with different concentrations depending on the ocular condition.

The blood is either drawn from the patient (autologous) or from a donor (allogenic), and the serum is then separated from the blood via a centrifuge to obtain a bright yellow, clear serum.<sup>25</sup> The tubes are then combined with 0.9% sodium chloride to make the desired concentration, which varies according to clinician discretion starting at 20%.<sup>25</sup> A 20% concentration tends to mimic the biological factors found in natural tears, which is why it is typically used in cases of dry eye, whereas concentrations of 40% to 50% are favored in corneal neuropathic pain to reduce photoallodynia by improving nerve density, decreasing nerve tortuosity and promoting epithelial healing.<sup>25</sup>

The dosage of serum tears may vary from TID to hourly, with the most common initial dose being four to eight times per day; many clinicians taper dosage over a few weeks depending of signs and symptoms of improvement.<sup>25</sup> Patients may notice an improvement in symptoms in as little as two weeks, but it may take closer to four to six weeks to see a clinical change in some cases.<sup>25</sup>

Unfortunate drawbacks to serum tears may include inaccessibility to treatment, cost and storage of medication. The cost of treatment depends on location, dosage, concentration and associated lab/preparation fees, which are all typically not covered by insurance carriers, since the use of serum tears is not a FDA-approved therapy for ocular surface diseases.<sup>25</sup>

Amniotic membrane—another catalyst to healing—was first used in 1910 as a skin graft substitute material.<sup>26</sup>



**Fig. 5.** This patient has a large area of epithelial disruption. There is a central epithelial defect and plaque, along with nasal neovascularization secondary to previous history of herpes zoster ophthalmicus keratouveitis and post-herpetic trigeminal neuralgia.

Ophthalmic uses began in the 1940s as a conjunctival tissue substitute.<sup>26</sup> Amniotic membranes are harvested from the innermost layer of the placenta. Thickness ranges from 20 $\mu$ m to 500 $\mu$ m and consists of multiple layers supported by a basement membrane.<sup>26</sup> This intervention has unique biological properties including lack of immunogenicity, the ability to preserve and support stem cells and inhibition of inflammation, angiogenesis and fibrosis.<sup>26</sup> In addition, improvement in pain and antimicrobial benefits have been observed.

Amniotic membranes come in different forms, typically cryopreserved or dehydrated. When placed on the cornea, dehydrated membranes are covered with a bandage contact lens (Figure 7). One study using cryopreserved amniotic membranes showed a decrease in neuropathic corneal pain from 6.3 to 1.9 (on a scale of 1 to 10) over a seven to 13-month follow-up period, with only two patients requiring repeat membrane placement.<sup>27</sup> This makes amniotic membranes a versatile tool to use in conjunction with other topical therapies to promote good corneal healing in cases of both neurotrophic changes and neuropathic pain.

**Anti-inflammatories.** Corticosteroids are typically considered a first-line option for corneal pain because of their ability to provide rapid relief.<sup>28</sup> These agents inhibit the activity of phospholipase A<sub>2</sub>, which is responsible for helping form prostaglandins and thromboxane A<sub>1</sub> while also inhibiting other major portions of the inflammatory cascade to help reduce vasodilation, vascular permeability and stabilize the cell membrane.<sup>28</sup> Typically, “soft” or low-dose steroids such as loteprednol or fluorometholone are used in cases where long-term treatment is needed, due to their reduced risks of IOP elevation and cataract formation compared with high-potency topical steroids such as prednisolone and difluprednate.

Topical cyclosporines are an immunomodulatory therapy that suppress the activation and function of T cells in order to reduce inflammation and relieve symptoms of ocular surface disease by downregulating inflammatory cytokines in the conjunctivae and lacrimal glands to improve conjunctival goblet cell density, increase tear production and decrease epithelial cell death.<sup>28,29</sup> Typically, these medications are prescribed to those who have

dry eye or inflammation related to an autoimmune condition. The regimen usually takes at least three weeks to three months to take effect and is most useful in controlling long-term chronic inflammation.

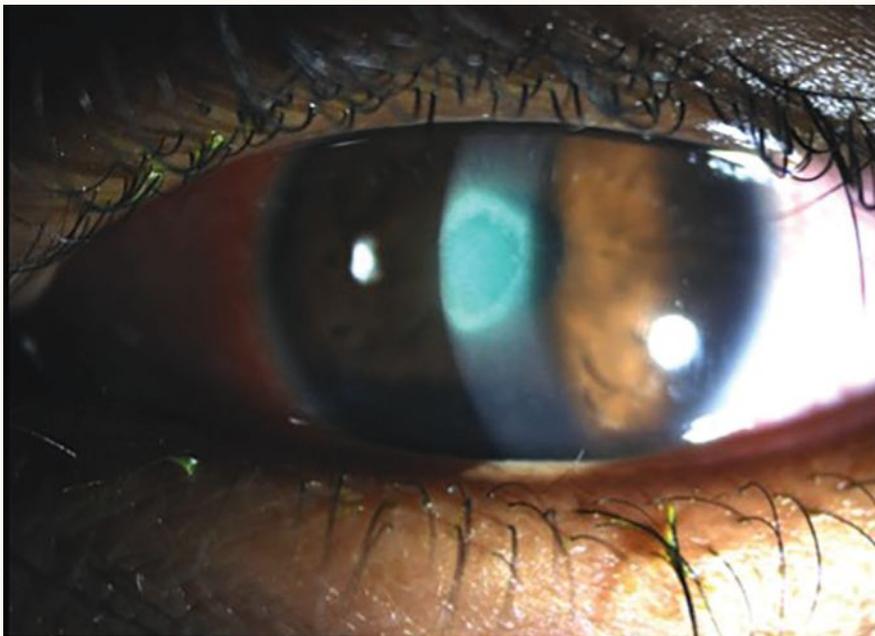
Another anti-inflammatory therapy is lifitegrast, (Xiidra, Bausch + Lomb), which decreases T-cell activation and recruitment by blocking the binding of intercellular adhesion molecule-1 to lymphocyte function-associated antigen 1.<sup>28</sup> This helps prevent the migration, proliferation and release of many pro-inflammatory cytokines at the conjunctiva and lacrimal glands. It has a much faster onset of action at two weeks when compared with topical cyclosporine, which is good for cases of acute inflammation when faster relief is needed. The difference in time to efficacy is due to their different mechanisms of actions when limiting T cell-mediated inflammation.

These various options can be useful in conjunction with other neuroregenerative therapies such as serum tears or cenegermin to help limit inflammation during the corneal nerve regeneration process.

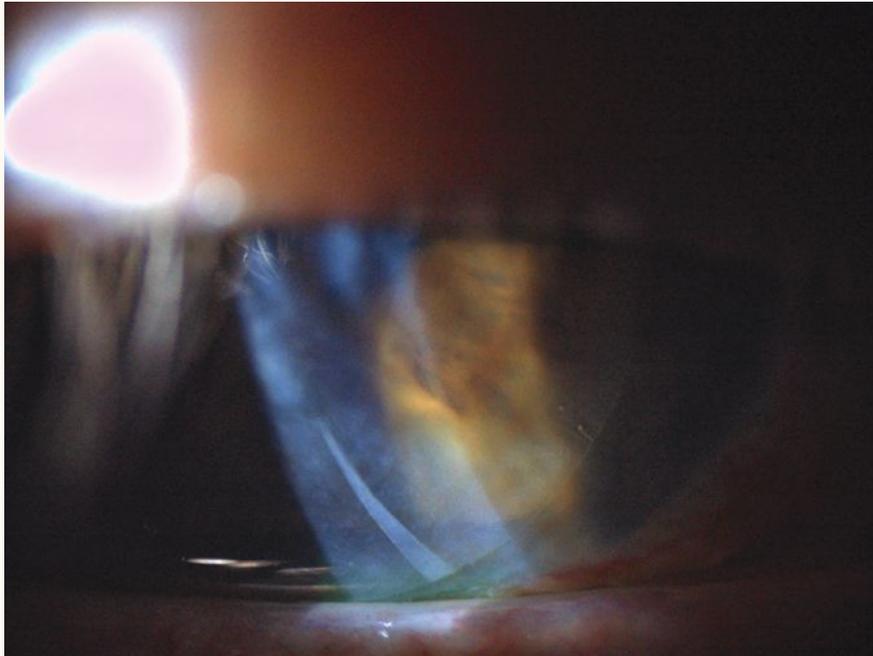
**Contact lenses.** Long used to promote corneal wound healing and reduce ocular pain, bandage contact lenses form a physical barrier against the mechanical forces of the lid, which is helpful for reducing the risk of neurotrophic changes and neuropathic pain. Silicone hydrogel lenses allow for overnight wear and improve mechanical protection when compared with older lens materials; they are used for short-term relief from acute conditions such as RCE, trauma, post-surgical pain and chemical burns.<sup>30</sup>

Scleral lenses, which form a moisture chamber and fluid reservoir against the mechanical forces of the lid, are used in chronic ocular surface conditions when long-term bandage lenses are needed.

In most circumstances, therapeutic contact lenses are used in conjunction with topical drops such as artificial tears, anti-inflammatories and/or antibiotics. Clinicians should be mindful of risk factors related to extended



**Fig. 6.** A young patient presented with a new red and painful eye with light sensitivity secondary to bacterial keratitis from sleeping in monthly contact lenses.



**Fig. 7.** This patient was fitted with a dehydrated amniotic membrane as seen underneath a bandage contact lens. There is mild folding of the dehydrated amniotic membrane as visible in the inferior cornea.

contact lens wear, including corneal edema, neovascularization and stromal infiltrates. Routine lens checks are recommended.

## Takeaways

Corneal neurotrophic changes and/or neuropathic pain can both be crippling ocular conditions, and it is essential to be aware of how they change a patient's quality of life. Corneal nerves are important, as they maintain integrity and are a source of neuropeptides that provide a trophic support and aid in mediating any healing response to the cornea. Optometrists should perform a thorough case history, an ocular surface work-up, administer an ocular pain survey and consider additional testing like corneal esthesiometry or the proparacaine challenge test to monitor for corneal nerve changes.

With recent advancements in therapeutics, clinicians now have a wide variety of treatment options to choose from that include neuroregenerative and anti-inflammatory therapies to help control and manage both neurotrophic changes and neuropathic pain. Hopefully, these conditions will

become more well understood as different testing methods and treatment options continue to develop in order to help patients overcome corneal nerve damage. ■

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OPTOMETRIC STUDY CENTER QUIZ

To obtain CE credit through the Optometric Study Center, complete the test form on the following page and return it with the \$35 fee to: Jobson Healthcare Information, Attn.: CE Processing, Jobson Healthcare Information, LLC/WebMD, 283-299 Market Street, 2 Gateway Center, 4th Floor, Newark, NJ 07102. To be eligible, please return the card within three years of publication. You can also access the test form and submit your answers and payment via credit card online at [revieweducationgroup.com](http://revieweducationgroup.com). You must achieve a score of 70 or higher to receive credit. Allow four weeks for processing. For each Optometric Study Center course you pass, you earn two hours of credit. Please check with your state licensing board to see if this approval counts toward your CE requirement for relicensure.

1. The cornea is innervated by which branch of the trigeminal nerve?

- a. Maxillary.
- b. Ophthalmic.
- c. Mandibular.
- d. None of the above.

2. Which one of these bacterial species is able to penetrate an intact cornea?

- a. Streptococcus.
- b. Staphylococcus.
- c. Listeria.
- d. Pseudomonas.

3. In which condition can serum tears be a useful treatment?

- a. Dry eye.
- b. Neurotrophic pain.
- c. Post-surgical complications.
- d. All of the above.

4. What is the most important symptom for distinguishing neurotrophic pain?

- a. Dryness.
- b. Pain sensation in response to light.
- c. Grittiness.
- d. Irritation.

5. The active ingredient in cenegermin 0.002% ophthalmic solution (Oxervate, Dompé) is what type of ophthalmic medication?

- a. Antibiotic.
- b. Recombinant human nerve growth factor.
- c. Analgesic.
- d. Steroid.

6. Which of the following is the FDA approved dosing pattern for cenegermin 0.002% in the treatment of neurotrophic keratitis?

- a. Once daily for 12 weeks.
- b. Twice daily for 12 weeks.
- c. Four times a day for eight weeks.
- d. Six times a day for eight weeks.

7. Which of these topical treatments can be added to limit corneal inflammation during nerve regeneration?

- a. Artificial tears.
- b. Cyclosporines.
- c. Antibiotics.
- d. None of the above.

8. Which of the following is NOT a potential cause of corneal neuropathic pain?

- a. Severe dry eye.
- b. Recurrent corneal erosion.
- c. Corneal chemical burn.
- d. Anterior uveitis.

9. Which of the following is NOT a risk factor for developing RCE?

- a. Prior history of trauma.
- b. Epithelial basement membrane dystrophy.
- c. Senile ectropion.
- d. History of corneal infections.

10. To reduce the risk of developing postherpetic neuralgia, how soon should patients be treated for herpes zoster?

- a. Three days.
- b. Five days.
- c. Seven days.
- d. Ten days.

11. What is the estimate annual incidence of recurrent corneal erosions?

- a. Five per 100,000.
- b. 15 per 100,000.
- c. 25 per 100,000.
- d. 30 per 100,000.

12. Chronic severe dry eye disease can lead to all of the following EXCEPT:

- a. Chronic ocular surface inflammation.
- b. Persistent epithelial defects.
- c. Neurotrophic keratitis.
- d. Dependence on soft contact lenses.

13. Which of the following systemic diseases is least likely to cause neuropathic corneal pain?

- a. Diabetes mellitus.
- b. Fibromyalgia.
- c. Hypertension.
- d. Trigeminal neuralgia.

14. Which of these treatments for corneal pain is derived from donor's blood?

- a. Allogeneic serum tears.
- b. Cenegermin 0.002%.
- c. Amniotic membranes.
- d. Autologous serum tears.

15. Which technique can be used to evaluate corneal nerve sensitivity?

- a. Biomicroscopy.
- b. Schirmer testing.
- c. Esthesiometer.
- d. Visual acuity.

16. Which survey was developed to assess ocular and corneal pain?

- a. OSDI.
- b. OPAS.
- c. SPEED.
- d. NEI-VFQ.

17. All of the following characteristics of bandage contact lenses are helpful in the treatment of neuralgia EXCEPT:

- a. Promotion of corneal wound healing.
- b. Decreased pain sensation.
- c. Increased ocular inflammation.
- d. Decreased foreign body sensation.

18. Which of the following is NOT true about amniotic membranes?

- a. They are harvested from the innermost layer of the placenta.
- b. They facilitate wound healing.
- c. They have anti-inflammatory properties.
- d. They only come as cryopreserved.

19. Isolated ophthalmic branch trigeminal neuralgia occurs in what percentage of patients with trigeminal neuralgia?

- a. 3%.
- b. 5%.
- c. 20%.
- d. 50%.

20. The global rate of new cases of herpes keratitis is estimated to be which of the following?

- a. 150,000.
- b. 1 million.
- c. 1.5 million.
- d. 5 million.

# Examination Answer Sheet

## Corneal Pain Presentations: Causes and Interventions

Valid for credit through April 15, 2027

**Online:** This exam can be taken online at [revieweducationgroup.com](http://revieweducationgroup.com). Upon passing the exam, you can view your results immediately and download a real-time CE certificate. You can also view your test history at any time from the website.

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

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

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

Jointly provided by PIM and the Review Education Group.

### Answers to CE exam:

- 1.  A  B  C  D
- 2.  A  B  C  D
- 3.  A  B  C  D
- 4.  A  B  C  D
- 5.  A  B  C  D
- 6.  A  B  C  D
- 7.  A  B  C  D
- 8.  A  B  C  D
- 9.  A  B  C  D
- 10.  A  B  C  D
- 11.  A  B  C  D
- 12.  A  B  C  D
- 13.  A  B  C  D
- 14.  A  B  C  D
- 15.  A  B  C  D
- 16.  A  B  C  D
- 17.  A  B  C  D
- 18.  A  B  C  D
- 19.  A  B  C  D
- 20.  A  B  C  D

### Post-activity evaluation questions:

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

- 21. Effectively distinguish between corneal pain presentations. ① ② ③ ④ ⑤
- 22. Accurately assess corneal pain in clinical practice. ① ② ③ ④ ⑤
- 23. Recognize the various causes of corneal pain and sensitivity. ① ② ③ ④ ⑤
- 24. Determine the best course of treatment for patients presenting with corneal pain. ① ② ③ ④ ⑤
- 25. Based upon your participation in this activity, do you intend to change your practice behavior? (Choose only one of the following options.)
  - A I do plan to implement changes in my practice based on the information presented.
  - B My current practice has been reinforced by the information presented.
  - C I need more information before I will change my practice.
- 26. Thinking about how your participation in this activity will influence your patient care, how many of your patients are likely to benefit? (please use a number):
- 27. If you plan to change your practice behavior, what type of changes do you plan to implement? (Check all that apply.)
  - A Apply latest guidelines
  - B Change in diagnostic methods
  - C Choice of management approach
  - D Change in current practice for referral
  - E Change in vision correction offerings
  - F Change in differential diagnosis
  - G More active monitoring and counseling
  - H Other, please specify: \_\_\_\_\_
- 28. How confident are you that you will be able to make your intended changes?
  - A Very confident
  - B Somewhat confident
  - C Unsure
  - D Not confident
- 29. Which of the following do you anticipate will be the primary barrier to implementing these changes?
  - A Formulary restrictions
  - B Time constraints
  - C System constraints
  - D Insurance/financial issues
  - E Lack of interprofessional team support
  - F Treatment related adverse events
  - G Patient adherence/compliance
  - H Other, please specify: \_\_\_\_\_
- 30. Additional comments on this course: \_\_\_\_\_

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### Rate the quality of the material provided:

1=Strongly disagree, 2=Somewhat disagree, 3=Neutral, 4=Somewhat agree, 5=Strongly agree

31. The content was evidence-based.

① ② ③ ④ ⑤

32. The content was balanced and free of bias.

① ② ③ ④ ⑤

33. The presentation was clear and effective.

① ② ③ ④ ⑤

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

Signature

Date

Lesson 124829 RO-OSC-0424

**tyrvaya**<sup>®</sup>  
(varenicline solution)  
nasal spray 0.03 mg

FOR THE SIGNS  
& SYMPTOMS OF  
DRY EYE DISEASE

SHE'S LOOKING TO YOU FOR A  
DIFFERENT APPROACH WHEN  
ARTIFICIAL TEARS ARE NOT ENOUGH.<sup>1</sup>

BEFORE ANOTHER DROP

# ACTIVATE REAL TEARS

WITH THE FIRST AND ONLY NASAL  
SPRAY FOR DRY EYE<sup>2</sup>



## Tyrvaya<sup>®</sup> is not another drop

It's an **ocular surface-sparing** nasal spray.<sup>2</sup>



## Activates real, basal tears

Tyrvaya<sup>®</sup> is believed to work by activating the trigeminal parasympathetic pathway resulting in **basal tear production**.<sup>2\*</sup>



## Real tears, real fast

In 2 clinical trials with **mild, moderate, and severe** dry eye disease patients, Tyrvaya increased tear production from baseline by **≥10 mm in Schirmer's Test Score (STS) in nearly 50% of patients at week 4**, with increased tears seen as early as the first dose and over 12 weeks.<sup>2-8†</sup>

SEE WHAT  
TYRVAYA  
CAN DO



\*The exact mechanism of action is unknown.

†Tyrvaya was evaluated across 3 randomized, vehicle-controlled, double-masked studies in which adults aged ≥22 years diagnosed with dry eye disease received 1 spray of either active drug or vehicle in each nostril twice daily. Primary endpoint: % of patients with mean change from baseline in STS of ≥10 mm at week 4 in ONSET-1: 52% with Tyrvaya (n=48) vs 14% with vehicle (n=43) and in ONSET-2: 47% with Tyrvaya (n=260) vs 28% with vehicle (n=252). Onset of action: mean change from baseline in STS ~5 minutes after first dose (not a prespecified endpoint) in ONSET-1 was 17.2 mm with Tyrvaya (n=48) vs 4.0 mm with vehicle (n=43) and in ONSET-2 was 16.5 mm with Tyrvaya (n=260) vs 6.9 mm with vehicle (n=251). Observed data. On Day 1 in clinical studies, a baseline anesthetized Schirmer's test was performed. Tyrvaya was then administered concurrently with Schirmer's test. Schirmer's test results were measured at ~5 minutes. Mean change from baseline in STS at week 12 in the MYSTIC study was 10.8 mm with Tyrvaya vs 6.0 mm with vehicle. Limitations: Ex-US, single-center study. All subjects were Hispanic or Latino. Tyrvaya group mean baseline STS 5.5 mm (n=41); vehicle group mean baseline STS 5.3 mm (n=41). All randomized and treated patients were included in the analysis and missing data were imputed using last-available data.<sup>2-8</sup>  
**See references on next page.**

## Indication

Tyrvaya<sup>®</sup> (varenicline solution) nasal spray is indicated for the treatment of the signs and symptoms of dry eye disease.

## Important Safety Information

The most common adverse reaction reported in 82% of patients was sneezing. Events that were reported in 5-16% of patients were cough, throat irritation, and instillation-site (nose) irritation.

Please see **Brief Summary of Prescribing Information on the next page and the full Prescribing Information at Tyrvaya-pro.com.**

**BRIEF SUMMARY:** Consult the full Prescribing Information for complete product information available at [www.tyrvaya-pro.com](http://www.tyrvaya-pro.com).

### **INDICATIONS AND USAGE**

TYRVAYA® (varenicline solution) nasal spray is a cholinergic agonist indicated for the treatment of the signs and symptoms of dry eye disease.

### **ADVERSE REACTIONS**

**Clinical Trials Experience:** Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

In three clinical trials of dry eye disease conducted with varenicline solution nasal spray, 349 patients received at least 1 dose of TYRVAYA. The majority of patients had 31 days of treatment exposure, with a maximum exposure of 105 days.

The most common adverse reactions reported in 82% of TYRVAYA treated patients was sneezing. Other common adverse reactions that were reported in >5% of patients include cough (16%), throat irritation (13%), and instillation-site (nose) irritation (8%).

### **USE IN SPECIFIC POPULATIONS**

**Pregnancy: Risk Summary:** There are no available data on TYRVAYA use in pregnant women to inform any drug associated risks. In animal reproduction studies, varenicline did not produce malformations at clinically relevant doses.

All pregnancies have a risk of birth defect, loss, or other adverse outcomes. In the US general population, the estimated background risk of

major birth defects and miscarriage in clinically recognized pregnancies is 2% to 4% and 15% to 20%, respectively.

**Data: Animal Data:** Pregnant rats and rabbits received varenicline succinate during organogenesis at oral doses up to 15 and 30 mg/kg/day, respectively. While no fetal structural abnormalities occurred in either species, maternal toxicity, characterized by reduced body weight gain, and reduced fetal weights occurred in rabbits at the highest dose (4864 times the MRHD on a mg/m<sup>2</sup> basis).

In a pre- and postnatal development study, pregnant rats received up to 15 mg/kg/day of oral varenicline succinate from organogenesis through lactation. Maternal toxicity, characterized by a decrease in body weight gain, was observed at 15 mg/kg/day (1216 times the MRHD on a mg/m<sup>2</sup> basis). Decreased fertility and increased auditory startle response occurred in offspring at the highest maternal dose of 15 mg/kg/day.

**Lactation: Risk summary:** There are no data on the presence of varenicline in human milk, the effects on the breastfed infant, or the effects on milk production. In animal studies varenicline was present in milk of lactating rats. However, due to species-specific differences in lactation physiology, animal data may not reliably predict drug levels in human milk.

The lack of clinical data during lactation precludes a clear determination of the risk of TYRVAYA to an infant during lactation; however, the developmental and health benefits of breastfeeding should be considered along with the mother's clinical need for TYRVAYA and any potential adverse effects on the breastfed child from TYRVAYA.

**Pediatric Use:** Safety and efficacy of TYRVAYA in pediatric patients have not been established.

**Geriatric Use:** No overall differences in safety or effectiveness have been observed between elderly and younger adult patients.

**References:** **1.** Jones L, Downie LE, Korb D, et al. *Ocul Surf.* 2017;15(3):575-628. **2.** Tyrvaya. Prescribing Information. Oyster Point Pharma; 2021. **3.** Oyster Point Pharma. Data on file. OPP-002 (ONSET-1) Clinical Study Report. August 4, 2019. **4.** Oyster Point Pharma. Data on file. OPP-101 (ONSET-2) Interim Clinical Study Report. October 13, 2020. **5.** Quiroz-Mercado H, Hernandez-Quintela E, Chiu KH, Henry E, Nau JA. *Ocul Surf.* 2022;24:15-21. **6.** Wirta D, Torkildsen GL, Boehmer B, et al. *Cornea.* 2022;4(10):1207-1216. **7.** Wirta D, Vollmer P, Paauw J, et al. *Ophthalmology.* 2021;0(0):379-387. **8.** Oyster Point Pharma. Data on file. OPP-004 (MYSTIC) Clinical Study Report. March 19, 2020.

Manufactured for Oyster Point Pharma, Inc. 202 Carnegie Center, Suite 106, Princeton NJ 08540. For more information, visit [www.tyrvaya-pro.com](http://www.tyrvaya-pro.com). To report an adverse event, contact 1-877-EYE-0123.



BY JESSICA STEEN, OD

## THERAPEUTIC REVIEW

# Twin Tumor Therapies

*Tivdak and Elahere are important advances for disease control in aggressive, often difficult-to-treat gynecological cancers.*

**A** 42-year-old woman with metastatic cervical cancer presented for baseline ophthalmic evaluation as referred by her oncologist prior to beginning a new systemic therapy, Tivdak (tisotumab vedotin, Seagen and Genmab). She reported mild fluctuating vision and occasional burning. Her best-corrected visual acuity (BCVA) was 20/20 OU with mild inferior corneal staining in each eye with unremarkable posterior segment. A second woman, a 58-year-old with metastatic ovarian cancer, had presented on the same day for ongoing ophthalmic care while receiving Elahere (mirvetuximab soravtansine, ImmunoGen). She had received her first infusion out-of-state and had recently relocated to Florida. She had significant posterior subcapsular cataract in each eye with BCVA of 20/70 OD and 20/25 OS and otherwise unremarkable anterior and posterior segments.

The recent availability of two particular treatments, Tivdak and Elahere,

represent important advances for disease control in two forms of aggressive, often difficult-to-treat gynecological cancers.<sup>1-4</sup> Both therapies have boxed warnings of ocular toxicity and have set protocols for ophthalmic examination and ophthalmic medications during therapy aimed to reduce the risk of ocular adverse events.<sup>1-4</sup> Understanding the necessary steps for individuals undergoing or set to begin therapy with Tivdak or Elahere is central for ongoing systemic therapy.

### Background

Tivdak is indicated as a second-line treatment and beyond for metastatic or recurrent cervical cancer, and Elahere is indicated for the treatment of folate receptor positive, platinum-resistant epithelial ovarian, fallopian tube or primary peritoneal cancer who have received one to three previous treatments.<sup>3,4</sup> Both options belong to a new class of cancer therapeutics called anti-

body-drug conjugates that (in comparison to chemotherapy) have high selectivity for cancer cells, which increases efficacy and minimize adverse effects.<sup>5</sup> Three segments of the drug—the monoclonal antibody, the cytotoxic payload and the linker—each play a specific role in the drug's efficacy.<sup>5</sup> The monoclonal antibody portion of the drug complex targets specific antigens on the surface of the

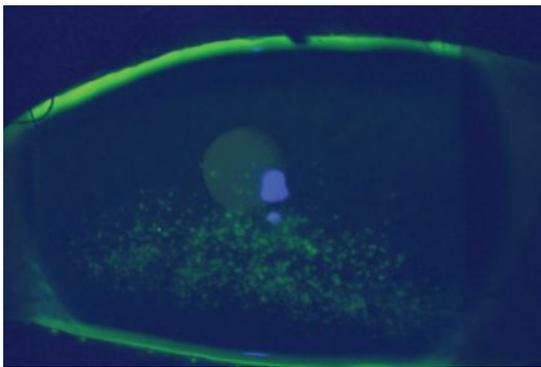
tumor cell, which leads to uptake of the complex by the cell. The antibody-drug complex is broken down and releases the cytotoxic payload into the tumor cell cytoplasm, ultimately leading to apoptosis.<sup>1,5,6</sup>

In the Phase II multicenter, single-arm, open-label trial that evaluated the safety and efficacy of Tivdak for treating recurrent or metastatic cervical cancer with disease progression on or after chemotherapy, of the 102 participants, 53% experienced ocular adverse effects.<sup>1</sup> The most common ocular adverse events were conjunctivitis (26%), dry eye (23%) and keratitis (11%) with median time to event of 1.4 months.<sup>1</sup> The ocular adverse event profile is thought to be due to an off-target event where Tivdak targets tissue factor, the drug's therapeutic target, present within the corneal epithelium.<sup>1</sup>

Elahere's safety and efficacy was evaluated in the Phase II SORAYA study, which enrolled women with folate receptor alpha-high expression with platinum-resistant epithelial ovarian cancer who received one to three prior therapies.<sup>2</sup> About 52% of the 106 patients enrolled in the trial experienced blurred vision or keratopathy, with median time to onset of 1.3 months.<sup>2</sup> The clinical ocular findings differ from those determined during Tivdak treatment. Punctate, often pigmented epithelial deposits and corneal flattening demonstrated on topography have been observed in individuals treated with Elahere.<sup>6,7,8</sup> The drug is thought to diffuse into the cornea and disrupt epithelial cell division through the limbal vasculature or via the tear film.<sup>8</sup>

### Adverse Effects

Eyecare monitoring and treatment protocols were implemented in each trial and are required for either treatment to



**Superficial punctate keratitis in an individual following one infusion of Tivdak.**

About  
Dr. Steen

**Dr. Steen** is an associate professor at Nova Southeastern University College of Optometry, where she serves as director of the Glaucoma Service, coordinator of the Primary Care with Emphasis in Ocular Disease Residency and teaches courses in glaucoma and ocular pharmacology. Her financial disclosures include Bausch + Lomb, Santen, Ocuphire, Carl Zeiss Meditec, Oyster Point Pharma, Ocuterra, Peripherex, Clearside Biomedical, Allergan, Iveric Bio, Alcon and Thea Pharma.

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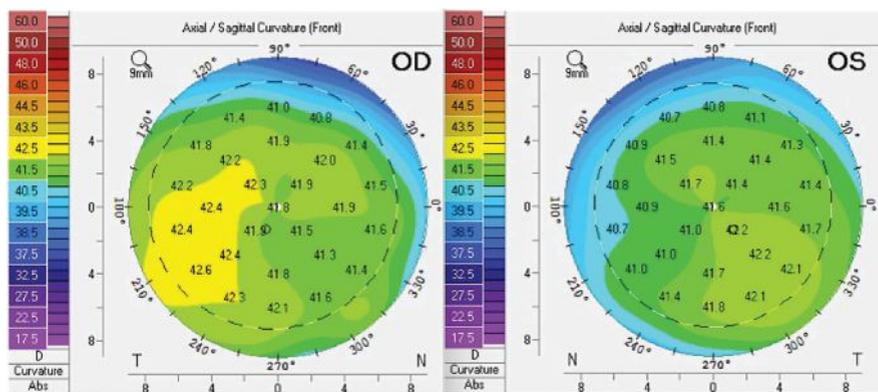


reduce the likelihood of serious ocular adverse event and ensure management of events if they occur.<sup>1-4</sup> Each drug has a specific assessment form that must be completed and made available to the managing oncologist to allow for continued treatment.<sup>3,4</sup> If ophthalmic examination is delayed—or the managing oncologist has not received the eye examination report at the time of scheduled infusion—treatment will be delayed. The eyecare plan for each medication considers the risk of ocular adverse effect and includes prophylactic topical ophthalmic treatment to reduce ocular adverse events.

For individuals treated with either Tivak or Elahere, the eyecare plan begins with a baseline assessment of visual acuity and an anterior segment evaluation.<sup>3,4</sup> At baseline, we also assess the health of the posterior segment through a dilated pupil, and, for those set to begin Elahere, baseline corneal topography. Considering systemic and topical ocular steroid use during therapy, we also measure intraocular pressure at baseline and at each following examination for patients on either treatment.

For women set to begin Elahere, mitigating ocular adverse events requires a strong topical steroid; for example, prednisolone acetate 1%, starting six times per day the day before each treatment cycle through day four of the cycle, and then four times daily from days five through eight of each cycle and preservative-free artificial tears.<sup>2</sup> Contact lenses should not be worn while undergoing therapy.<sup>2,3</sup> The topical ocular steroid may help to reduce ocular adverse effects, leading to systemic dose reduction by reducing corneal epithelial cell proliferation and Elahere-corneal microcyst formation rather than through the reduction of inflammation.<sup>7</sup> While undergoing therapy, anterior segment examination, VA assessment and completion of the ocular assessment form are required every other cycle (every six weeks) for the first eight cycles.<sup>2,3</sup>

The ocular adverse mitigation strategy for Tivdak looks a little different. After a patient's baseline assessment, evalua-



**Corneal tomography without evidence of corneal flattening in an individual following four infusions of Elahere.**

tion and reporting is required prior to each infusion or every three weeks.<sup>1,4</sup> The prophylactic therapeutic strategy specifies three drops of brimonidine 0.2% for vasoconstriction instilled into each eye immediately prior to each infusion and topical ophthalmic steroid (we use prednisolone acetate 1%) TID for three days beginning just before the infusion.<sup>9</sup> Additionally, preservative-free artificial tears are recommended four times daily. Patients also receive eye cooling pads during the infusion.<sup>1,4</sup>

### Management

For each patient, the drug-specific ocular assessment form was completed with one copy provided directly to the patient to bring to their next infusion appointment and a second copy, along with a summary report, sent to the oncologist's office. For both treatments, the pre-specified ophthalmic medications were prescribed and reviewed with the patients. We also provided patients with clear printed medication instructions, and advised them to use preservative-free artificial tears four times daily throughout treatment.

The 58-year-old woman has undergone four cycles of Elahere so far without development of ocular adverse event. The 42-year-old woman treated with Tivdak had initial worsening of her keratitis accompanied by a two-line reduction in visual acuity, which was determined to be a grade 2 event. She had reported to be using brimonidine TID OU and prednisolone acetate 1% TID OU daily, rather than only on the day of

the infusion (brimonidine 0.2%) and for 72 hours following the infusion (prednisolone acetate 1%). After discussion with her oncology team, the woman on Tivdak continued systemic therapy as planned with an increase of preservative-free artificial tears and reduction of topical ophthalmic medication outlined in the treatment protocol with improvement in corneal staining and return to baseline VA at her most recent visit. ■

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BY JAMES L. FANELLI, OD

## GLAUCOMA GRAND ROUNDS

# Enough Data to Track Glaucoma Patients?

*It can be challenging to obtain adequate info when fundamental glaucomatous damage markers are blocked for other reasons.*

**W**hen you've been in practice for many years and the number and variety of glaucoma scenarios you've encountered is rather large, you learn to manage these patients the best you can with the information that is available to you. For example, some patients physically are unable to perform visual field testing and OCT imaging; some cannot be examined with a slit lamp. Still others have media opacification that prohibits adequate visualization of the posterior pole. So, how do you handle them? This recent scenario is a perfect example of maximizing use of our technology to gather as much information as is possible.

### Case

In early February of this year, a 92-year-old Caucasian woman presented to the office to establish care with me. She had been a lifelong resident of the area and was seen by a general ophthalmologist for many years before they retired. That practice was absorbed by a different group and she received care from this facility for the past few years. However, she grew disillusioned with the lack of personalized care, thus the change to my office.

She is a pleasant and spry 92-year-old who carries with her the following ophthalmic diagnoses: aphakia, severe macular degeneration, advanced glaucoma and low vision.

Her current ophthalmic medications included dorzolamide BID OU, 0.5% timolol BID OD and Rhopressa (netarsudil ophthalmic solution 0.02%, Alcon) HS OU. Systemic medications being taken included amlodipine QD, an unknown statin, Avapro (irbesartan, Sanofi), levothyroxine and vitamin D supplementation; she reported no known allergies to medications. Her entering visual acuities were 20/60 OD and hand motion at five feet OS. A refraction was not performed, as the aim of this initial visit was not refractive in nature. There was surgical distortion of both pupils and ipsilateral pupillary reactions were relatively normal. Extraocular movements were full in all positions of gaze. Applanation tensions were 14mm Hg OU at 10:20 AM. Pachymetry readings were 587 $\mu$ m OD and 585 $\mu$ m OS.

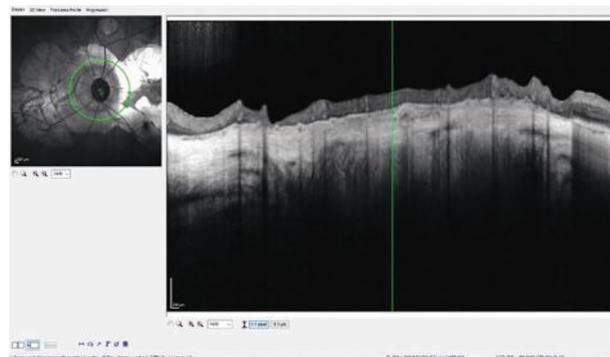
A slit lamp exam of the anterior segments revealed sectoral surgical iridectomies OU, vortex epitheliopathy OU, guttatae and mild striate keratopathy OU and a papilloma on the left upper lid nasally. Anterior chambers were deep and quiet OU with no cells, flare nor vitreous present bilaterally. The patient was aphakic OU.

Through dilated pupils, the vitreous was relatively intact without prolapse. The cup-to-disc ratio was estimated *in vivo* to be about 0.55x0.55 OD and 0.55x0.75 OS. The remaining neuroretinal rims were slightly pale bilaterally and there was clear erosion of the inferotemporal rim OS. There was significant peripapillary atrophy OU.

Both maculae were consistent with geographic atrophy (GA), with the left much worse than the right. Fortunately, the right foveal avascular zone was minimally affected by the GA. However, the GA in the left eye was extensive and coalesced with the peripapillary atrophy. The retinal vasculature was mildly attenuated and the peripheral retinal evaluation was remarkable for scattered areas of pavingstone degeneration.

Given the decreased visual acuity secondary to the GA as well as time limitations, a visual field was not performed at this visit, but OCT images were obtained bilaterally.

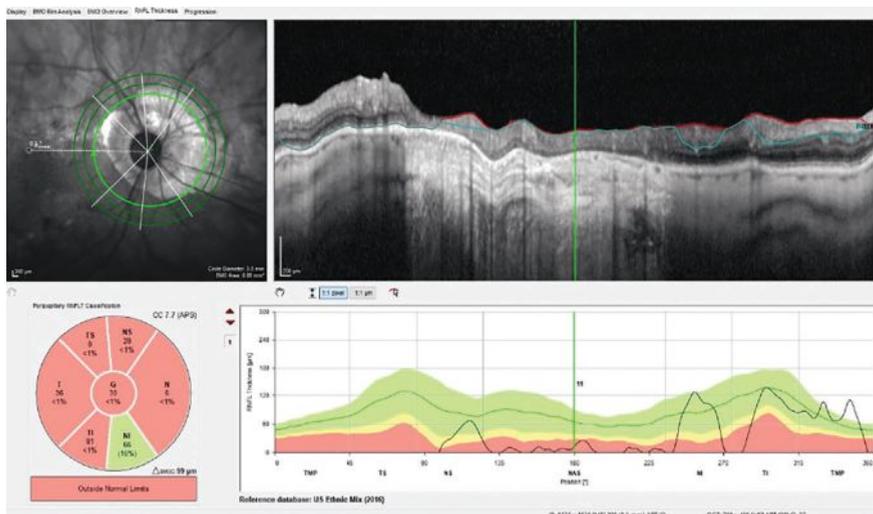
My glaucoma protocol in-office for OCT imaging involves using the GMPE software on the Heidelberg Spectralis, which offers many advantages, especially in cases such as this. *Figure 1* is a typical OCT scan of the periopic retinal nerve fiber layer (RNFL); in this case, of the patient's left eye. Note



**Fig. 1. Note the complete undermining of the RNFL measurements by the PPA, thereby complicating interpretation of this parameter related to glaucoma.**

About  
Dr. Fanelli

**Dr. Fanelli** is the founder and director of the Cape Fear Eye Institute in Wilmington, NC. He is chairman of the EyeSki Optometric Conference and the CE in Italy/Europe Conference. He is an adjunct faculty member of PCO, Western U. and UAB School of Optometry. He is on advisory boards for Heidelberg Engineering and Glaukos.

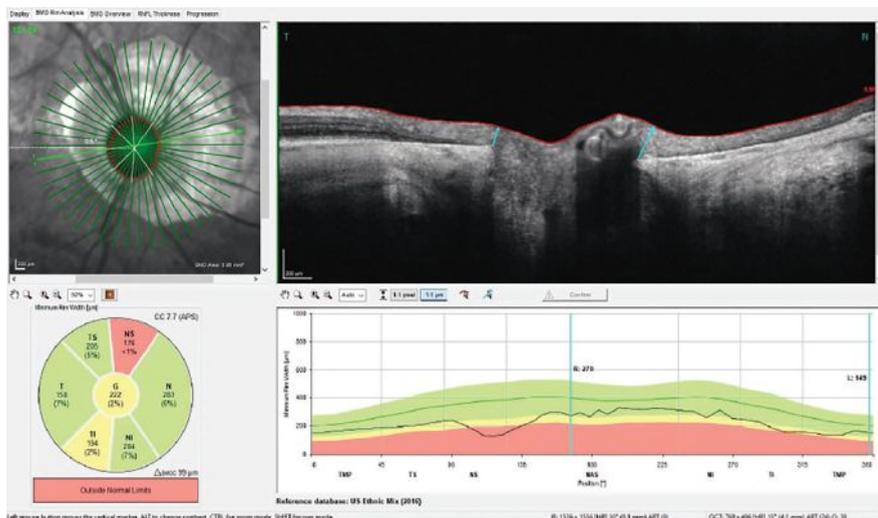


**Fig. 2.** The 3.5mm RNFL circle scan of the right optic nerve using the GMPE software. Note the relatively unencumbered 4.1mm and 4.7mm diameter circle scans.

the peripapillary atrophy (PPA) and the geographic atrophy affecting the entire area measured in this single circle scan. Notice also the paucity of peripapillary neurosensory retinal tissue with loss of retinal integrity. This combination of GA and PPA in the peripapillary area negates accurate interpretation of RNFL thickness, one of the fundamental markers of glaucomatous damage. In essence, progression of the glaucoma would not be able to be seen in this type of scan moving forward.

Compare and contrast *Figure 1* with *Figure 2*. In *Figure 2*, we are looking at one of five GMPE software images available of the patient's right eye. Specifically, this is at the 3.5mm RNFL circle scan. This particular scan is the innermost of three different diameter RNFL circle scans and is also affected by the PPA seen OD. Though the PPA OD is not as advanced as that of OS, it still affects interpretation of the RNFL thickness in this particular diameter scan. However, note that this is only one of three different diameter RNFL circle scans, with the other two being larger in diameter. In the next two larger 4.1mm and 4.7mm diameter scans, the entire temporal half of the RNFL scans are not influenced by the underlying PPA; this offers these circle scans the ability to detect glaucomatous progression in the temporal RNFL away from the optic nerve.

As has been mentioned in this column regularly, OCT analysis of the Bruch's membrane opening minimum rim width (BMO-MRW) gives us details of the actual neuroretinal rim, seen in *Figure 3*. This shows individual locations of the radial scans through the optic nerve, each measuring the neuroretinal rim thickness. The individual scan highlighted is roughly a horizontal scan; note the relatively robust neuroretinal rim and clear edge of the PPA on the temporal side of the disc. Note also in the reference database plot the rather minimally-affected neuroretinal rim 360° in the right optic nerve, indicating moderate, not severe, glaucoma. This



**Fig. 3.** The radial scans through the neuroretinal rim of the right eye measuring the BMO-MRW, which is completely unaffected by the PPA.

scan becomes the perfect one to use and examine in all follow-up visits, as the neuroretinal rim thickness measurements are not affected by the PPA.

## Discussion

If we were simply looking at one RNFL circle scan overlying a significant area of PPA, our ability to monitor the patient for progression would be severely limited. Having several different parameters of the posterior pole to evaluate in the context of glaucoma grants us the ability to find one or two parameters to use moving forward to monitor progression, such as the BMO-MRW demonstrated here.

Though field studies have not been performed on this patient yet, what strategy would be best used, given her decreased vision? When she is seen for her next visit, visual fields will be included via a VR headset field using the Olleyes VisuAll device. Since visual fields are obtained bilaterally, and given her better-seeing right eye, the right eye can be used as the fixating eye, hopefully giving us a bit more accurate visual field result (at least in the left eye) than if the left eye was unilaterally being tested and asked to fixate, which would certainly result in a poor-quality field result. Having the tools in your glaucoma toolbox helps tremendously to accurately manage your patients, independent of degree of glaucomatous damage present. ■



# Closed Off

*This condition is rarely seen in a typical healthy population.*

BY RAMI ABOUMOURAD, OD, AND LINSEY BERGSTROM, OD  
MIAMI

**A** 35-year-old Hispanic male presented with acute onset painless “cloudy vision” OD for four days. The patient recalled a similar event of transient monocular vision loss OD four months prior that was self-limiting within three hours that he never sought medical care for. Medical history was unremarkable. Entrance VA was 20/20 OD and OS, pupils were equally round and reactive without RAPD, and confrontation visual fields and extra-ocular motilities were full OU. IOP was 15mm Hg OD and 14mm Hg OS. Slit lamp examination was unremarkable.

## Take the Retina Quiz

- Which of the following is NOT a clinical feature present on exam?
  - Central retinal vein occlusion (CRVO).
  - Paracentral acute middle maculopathy.
  - Cilioretinal artery occlusion.
  - All of the above.
- Regarding the imaging, which of the following is false?
  - There are multifocal paracentral hyperreflective bands in the inner nuclear layer (INL) and outer plexiform layer (OPL).
  - There are multifocal paracentral hyperreflective bands in the outer nuclear layer (ONL) and OPL.
  - There is peripapillary inner-retinal hyperreflectivity.
  - There is peripapillary retinal thickening present.

- What is the most appropriate next step?
  - Emergent stroke work-up.
  - Intravitreal anti-VEGF agent.
  - Observation.
  - Outpatient hypercoagulable work-up.
- What test should be performed at follow-ups for patients with recent ischemic CRVO?
  - Gonioscopy.
  - Fundus photos.
  - OCT retinal nerve fiber layer.
  - Electroretinogram.
- Which of the following is NOT a risk factor for the patient’s presentation?
  - Cigarette smoking.
  - Lipoprotein A.
  - Oral contraception.
  - All of the above are risk factors.

*For answers, see page 90.*

## Diagnosis

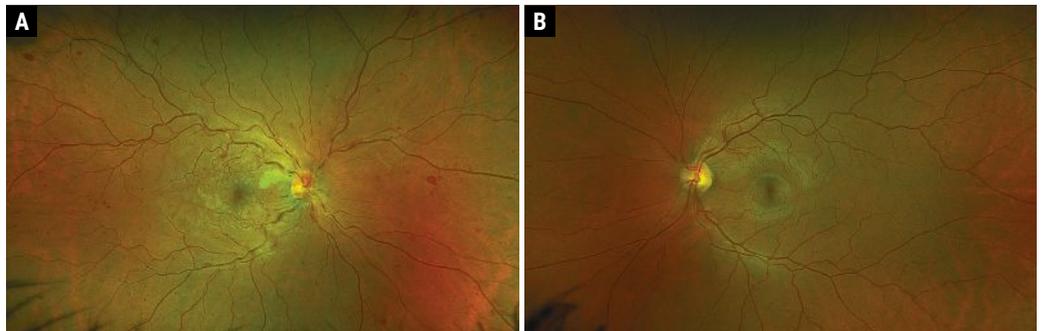
Fundus examination revealed diffuse dilated, tortuous and enlarged vessels with intraretinal and white-centered hemorrhages in all four quadrants OD (Figure 1a). There was also faint multifocal paracentral retinal whitening and confluent peripapillary retinal whitening. Of note, there was no neovascularization

of the disc or elsewhere. Macular OCT showed multifocal paracentral hyperreflectivity within the INL and OPL (Figure 2a), as well as confluent inner-retinal thickening and hyperreflectivity adjacent to the optic nerve OD (Figure 2b). Fundus exam and OCT were normal OS (Figures 1b and 2c).

Our patient was diagnosed with a combined CRVO with paracentral acute middle maculopathy (PAMM) and cilioretinal artery occlusion (CLRAO), which prompted immediate transfer to our affiliated general hospital for emergent stroke work-up. He underwent extensive bloodwork and neuroimaging, which revealed marked hyperlipoproteinemia(a) measuring 222nmol/L.

## Discussion

Combined CRVO/CLRAO is present in 27% to 62% of all CLRAOs. The most common risk factors for CRVO +/- CLRAOs are age greater than 50 years, hypertension, hyperlipidemia, diabetes, cigarette smoking and a positive family history of cardiovascular disease; it is rarely seen in an otherwise healthy population.<sup>1</sup> Patients often describe a “dark spot” in their vision with typical fundus features of dilated and tortuous vessels, intraretinal hemorrhages in all quadrants, cotton wool spots and optic disc edema; retinal artery occlusion (RAO), when present, may show segmental or confluent retinal whitening.<sup>1,2</sup>



**Fig. 1. Optos ultrawidefield fundus photograph of OD (A) and OS (B).**

About Dr. Aboumourad

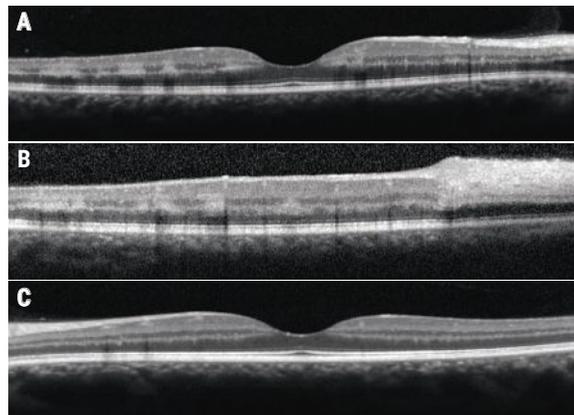
Dr. Aboumourad currently practices at Bascom Palmer Eye Institute in Miami. He has no financial disclosures.

PAMM can be seen in a broader age range of patients due to variable etiologies but is more frequently found concomitantly with CRVO +/- RAO.<sup>3</sup> Clinically, PAMM lesions appear subtly white/gray and on OCT show hyperreflective bands within the INL and OPL.<sup>3</sup> While PAMM can be idiopathic, it warrants systemic evaluation to rule out occult etiologies.<sup>3</sup>

Lipoprotein A, or Lp(a), is a form of low-density lipoprotein involved in tissue repair and wound healing within the body.<sup>4</sup>

Lp(a) is also a known risk factor for atherosclerosis, coronary artery disease, stroke, thrombosis and aortic stenosis.<sup>4</sup> Up to about 90% of plasma Lp(a) levels are determined by the LPA gene, making Lp(a) a non-modifiable risk factor and LPA gene expression is variable due to size polymorphism.<sup>5,6</sup> This results in a wide range of Lp(a) levels within the population, and makes it challenging to come up with a high-risk threshold value. However, studies suggest plasma levels greater than 30mg/dL to 50mg/dL (75nmol/L to 125nmol/L) are correlated with an increased risk of cardiovascular disease.<sup>7,8</sup> Current literature has demonstrated greater levels of Lp(a) within African populations vs. Caucasian and Hispanic populations.<sup>9</sup>

The role of Lp(a) in retinal vascular occlusion is thought to be a twofold pathogenic process.<sup>10</sup> First, Lp(a) acts on retinal arterioles and venules by increasing vascular inflammation and has a strong affinity for the glycosaminoglycans within the arterial walls of humans.<sup>10,11</sup> As it lodges itself within the walls, it recruits pro-inflammatory factors, which induces degeneration and scarring of the walls.<sup>11</sup> This process leads to restricted blood flow and thrombus formation. Additionally, Lp(a) impairs the fibrinolysis process, making an individual more prone to clotting.<sup>10</sup> The above mechanism can produce both retinal arterial and venous occlusions by way of arteriolar stenosis, thrombus formation and impaired fibrinolysis, accounting for this patient's clinical presentation.



**Fig. 2. (a) Foveal OCT OD. (b) Eccentric OCT superior to fovea. (c) Foveal OCT OS.**

Lp(a) is a known independent risk factor for heart disease, even in young and otherwise healthy patients.<sup>4</sup> While its role in retinal disease is a budding area of research, studies suggest a correlation between CRVO and hyperlipoproteinemia(a).<sup>10</sup> This raises the question of whether Lp(a) should be included in the routine work-up for young patients with CRVO/RAO without known risk factors, as well as what to do with borderline positive results given our incomplete understanding of what constitutes a normal range.

## Treatment

Ophthalmic intervention depends on the presentation. Non-ischemic CRVOs without cystoid macular edema are monitored with serial dilation and macular OCT.<sup>12</sup> Ischemic CRVOs should be followed more closely, typically once a month for the first six months with serial gonioscopy to monitor for anterior segment neovascularization (seen in about 50% of patients).<sup>12</sup> Both neovascularization and cystoid macular edema are indications for intravitreal anti-VEGF injections.<sup>12</sup> Systemic work-up is indicated in young patients or those without an obvious systemic risk factor. PAMM and RAOs are often managed similarly as warranting an immediate systemic evaluation to rule out concomitant cerebrovascular accident or underlying etiology requiring intervention.<sup>3,13</sup>

In the case of hyperlipoproteinemia(a), patients should establish care with a cardiologist who is likely to initiate lipid-

lowering therapy. Currently, there are no drugs on the market directly targeting Lp(a). However, studies have shown reduction in Lp(a) levels with statins, aspirin (15% to 20%), PCSK9-inhibitors (30%) and nicotinic acid (38%).<sup>4</sup> At present, the only FDA-approved therapy to directly reduce Lp(a) levels is lipoprotein apheresis which yields a 60% to 80% reduction in Lp(a) levels but is reserved for more extreme disease states.<sup>14</sup>

Our patient was started on atorvastatin 80mg and aspirin 325mg daily in the emergency

department and is currently under the care of the cardiology team. Additionally, he has been followed by our retina service with resolution of PAMM lesions and no occurrence of neovascularization or cystoid macular edema, and his vision has remained stable at 20/20. ■

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## ABOUT THE CO-AUTHOR



**Dr. Bergman** graduated from the University of Houston College of Optometry and is completing an ocular disease residency at Bascom Palmer Eye Institute.

Faculty



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Candidates expressing interest in practice areas of Strabismus, Vision Therapy, Acquired Brain Injury and/or Sports Vision are desired. Candidates must be willing to actively participate in curricular assessment, professional development, student counseling and service activities within the college, university and the scientific community. Successful candidates are also expected to be involved in research and scholarly activities, and have a sincere commitment to optometric education, community service and patient care. Primary duties include, but are not limited to:

- |  |  |  |
|--|--|--|
| <p><b>a) Teaching</b></p> <ul style="list-style-type: none"> <li>Developing and delivering lectures and/or laboratories for primary eye care, pediatrics/vision therapy and other related areas, as assigned;</li> <li>Embracing and enhancing the didactic philosophies in the O.D. program;</li> <li>Maintaining and expanding the high quality clinical practice environment for optometry students on rotation;</li> <li>Precepting students on clinical rotation at the Midwestern University Eye Institute; Therapy Institute</li> </ul> | <p><b>b) Service</b></p> <ul style="list-style-type: none"> <li>Helping to maintain and grow the state of the art primary eye care service with a strong interdisciplinary focus that meets the needs of patients in the surrounding community; is efficient, patient friendly, and cost-effective;</li> <li>Working closely together with all optometry and ophthalmology faculty to provide a complete range of eye and vision care services;</li> <li>Participating in leadership roles in state, regional, and national optometry organizations;</li> <li>Participating on College and University committees,</li> </ul> | <p>as assigned;</p> <ul style="list-style-type: none"> <li>Participating in College and University service activities</li> </ul> <p><b>c) Scholarly activity</b></p> <ul style="list-style-type: none"> <li>Engaging in scholarly activity, including presentations at scientific meetings, research, and publication in peer-reviewed journals</li> </ul> |
|--|--|--|

**Qualifications:** Candidates must possess a Doctor of Optometry (O.D.) degree from an ACOE accredited institution, must have completed an ACOE-accredited residency in Pediatrics/Vision Therapy or related fields, and must be eligible for an Arizona optometric license. Primary eye care clinic expertise is also required.  
**Salary:** Salary will be commensurate with qualifications and experience.

**Contact Information:** Inquires may be directed to:  
 Alicia Feis, O.D. Dean, Arizona College of Optometry  
 Midwestern University  
 19555 North 59th Avenue  
 Glendale, AZ 85308  
 By Email: [afeis@midwestern.edu](mailto:afeis@midwestern.edu)

**Application:** Please submit your application packet through Midwestern University's online job board:  
 1. Visit <https://www.midwestern.edu/>  
 2. Select 'Careers at MWU' scroll to the bottom of the page under Resources  
 3. Select 'View Current Job Openings'  
 4. Select 'faculty' for job category and click 'search'. The online profile should include a letter of interest (uploaded as an attachment), curriculum vitae (uploaded as an attachment).

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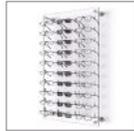
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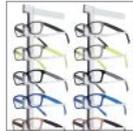
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BY DEREK N. CUNNINGHAM, OD, AND  
WALTER O. WHITLEY, OD, MBA

## SURGICAL MINUTE

# Hot Topic

*Same-day bilateral cataract surgery, while controversial, is making waves worldwide.*

In this month's column, we are breaking from the usual format of spotlighting particular procedures to talk about an interesting debate going on cataract surgery circles right now.

We've all had the following questions asked by patients: What is a cataract? Who do we go to for surgery? What should we expect for the procedure? Which IOLs should we consider? But how many of you have had the discussion with patients about them having both eye surgeries performed at the same time? Most probably haven't; however, this is a consideration we could potentially hear about in the future.

Immediate sequential bilateral cataract surgery (ISBCS) is a surgical protocol performed on both eyes on the same day but as separate procedures to minimize infection risk.<sup>1</sup> Although rarely performed in the United States and somewhat controversial worldwide,

ISBCS is being performed due to its potential benefits and patient satisfaction. In our experience, we've had a handful of patients undergo ISBCS due to health and systemic safety considerations.

While we optometrists don't perform the procedure, it's important for us to educate patients when doing referrals for cataract surgery, as well as stay in the loop about trends, conversations and controversies in cataract surgery. Here, we will discuss the pros and cons of ISBCS and the issues at stake.

### Why ISBCS Should Be Considered

Currently, an estimated 3.5 million patients have cataract surgery each year in the US, with the vast majority of them being performed in the context of delayed sequential bilateral cataract surgery (DSBCS).<sup>2</sup> This protocol is the standard of care in the US we're all familiar with. Nonetheless, with the growth and aging of our population, the need and demand for cataract surgery will continue to increase; however, the supply of surgeons available is not adequate. Across a future 15-year time span, researchers report that the total ophthalmology supply is projected to decrease by 2,650 full-time ophthalmologists, equating to a 12% decline. Meanwhile, the

total demand is projected to increase by 24%, or 5,150 full-time ophthalmologists, representing a supply and demand mismatch of 30% workforce inadequacy.<sup>3</sup>

### Evolution of Cataract Surgery

Cataract surgery has changed dramatically over the last four decades, but many of our general policies and even practice patterns have been slower to adapt. Decades ago, cataract surgery was much more involved and thus carried more complications and a longer recovery time. Initial precautions were based around intracapsular cataract extraction, where the entire lens and capsule were both removed through relatively large incisions that required suturing. For this reason, we often wanted a significant period of time to elapse to ensure the first eye was stable before considering surgery on the other eye.

A giant leap occurred once extracapsular cataract extraction with phacoemulsification became popular, but even early versions of this were considerably more complication laden than what we are accustomed to now. Conventional cataract surgery has become dramatically safer and more predictable because we disrupt much less tissue, use less and more precise intraocular energy, and spend very little time in the eye.

Current cataract surgery is typically performed through an incision that's less than 3mm in length and rarely requires suturing. Typical cases are often completed in under eight minutes after the primary incision is made. Energy applied through phacoemulsification is kept to a minimum and very precise. Although there is always variability in the human population, it is common for patients to have no pain and functional vision the next day.

#### FACTORS THAT WOULD ENCOURAGE MD ADOPTION OF ISBCS

Medicolegal/indemnity insurance approval	65.4%
Improved evidence of safety and effectiveness	41.1%
Specialist society or academy approval	38.3%
Availability of prepacked right eye/left eye instruments	32.7%
Improved availability of intracameral antibiotics	29.9%
Other	19.6%
I would not consider under any circumstances	12.1%

Adapted from Rush SW, Guerrero Criado AE, Kezirian GM, Durrie D. Immediate sequential bilateral cataract surgery: opinions among refractive surgeons in the United States and a comparative analysis with European consultants. *J Ophthalmol.* 2022;8310921.

About Drs.  
Cunningham and Whitley

Dr. Cunningham is the director of optometry at Dell Laser Consultants in Austin. He has no financial interests to disclose. Dr. Whitley is the director of professional relations and residency program supervisor at Virginia Eye Consultants in Norfolk, VA. He is a consultant for Alcon.





# The Enemy Within

*A patient presents with anterior uveitis as well as several systemic conditions, plus retinal detachment. What's going on?*

**A** 68-year-old gentleman presented to the ophthalmology department in consultation from the general medicine floor. He had been admitted for fever and fatigue but was confirmed as COVID negative. Following laboratory testing, it was confirmed he was in end-stage renal failure with poorly controlled hypertension and diabetes. The patient was a poor historian, not recalling that he had cataract surgery in both eyes in Columbia.

His chief complaint was decreased vision in the right eye of five days' duration. The eye was red but not painful. He reported no allergies.

## Clinical Findings

Examination was completed at the bedside. His best entering visual acuities were counting fingers at three feet OD and 20/40 uncorrected OS. There was no retinoscopic reflex in the right eye; the reflex in the left eye was normal, indicating gross emmetropia. His extraocular motilities were intact in both eyes but his confrontation field was restricted in the right eye, showing



**Slit lamp photo and ultrasound of our patient. Would you expect to see these presentations together?**

no peripheral awareness. The confrontation field in the left eye was normal. There was an afferent pupil defect, right eye.

The gross examination of the anterior segment is demonstrated in the photograph. Intraocular pressures measured 12mm Hg in the right eye and 16mm Hg in the left by Tono-Pen. There was no evidence of rubeosis or ectropion uvea in either eye. Dilated examination demonstrated no view of the fundus OD and increased cupping (0.6) with mild nonproliferative diabetic retinopathy without macular edema OS.

## Additional Testing

The patient was able to be transported to the office, where a proper slit lamp examination of the anterior segment demonstrated a hypopyon uveitis and dense vitritis OD. Binocular biomicroscopic indirect 90D lens examination was completed on both eyes. Anterior and posterior segment photography was completed. B-scan ultrasonography is demonstrated in the photograph and reveals a complete funnel-shaped retinal detachment, without evidence of serous retinal detachment or fibroproliferative debris.

## Your Diagnosis

What would be your diagnosis in this case based on the presentation? What's the likely prognosis? What's an appropriate intervention? To find out, read the online version of this article at [www.reviewofoptometry.com](http://www.reviewofoptometry.com). ■

**About Dr. Gurwood** Dr. Gurwood is a professor of clinical sciences at The Eye Institute of the Pennsylvania College of Optometry at Salus University. He is a co-chief of Primary Care Suite 3. He is attending medical staff in the department of ophthalmology at Albert Einstein Medical Center, Philadelphia. He has no financial interests to disclose.

## Retina Quiz Answers (from page 84)—Q1: d, Q2: b, Q3: a, Q4: a, Q5: d

### NEXT MONTH IN THE MAG

In May, we present our 25th annual issue devoted to dry eye topics. Articles will include:

- Dry Eye: Matching Patients and Treatments
- All About OFAs for Dry Eye: What We Know, What to Do

- Nail That Dry Eye Diagnosis: Tips for Busy ODs
  - Autoimmune Dry Eye: How to Understand, Identify and Manage
- Also in this issue:*

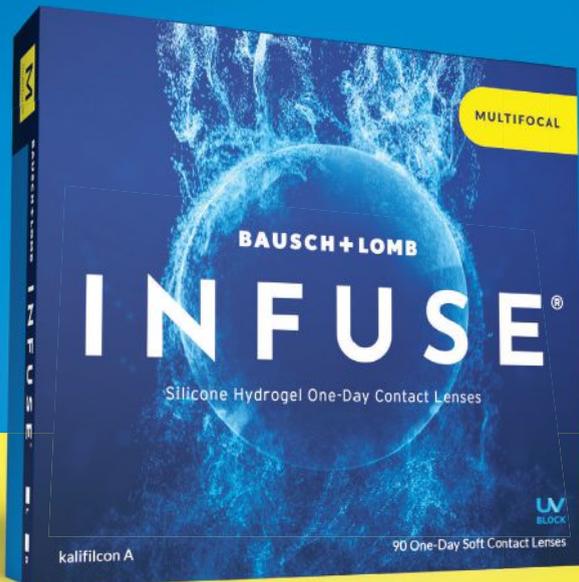
- Glaucoma: Pearls for Improving the Patient Experience
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