

RCCL®

REVIEW OF CORNEA & CONTACT LENSES

SPECIAL ISSUE:

Perspectives on Presbyopia

Supplement to

REVIEW OF OPTOMETRY

Understanding the Optics of Multifocals

Transitioning the Emerging Presbyope

Myriad Multifocals: How to Choose?

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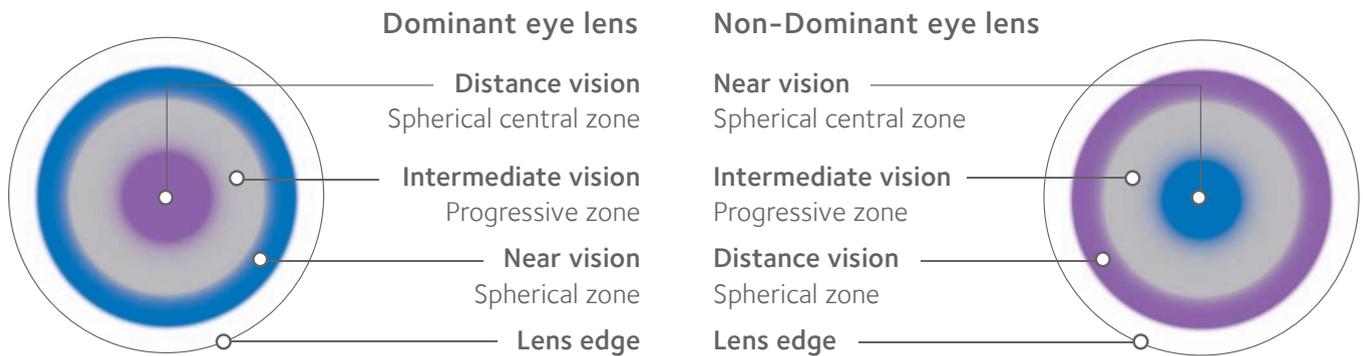
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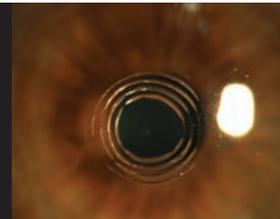
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Which Single-Agent Therapy is Best for Fungal Keratitis?

Natamycin may be better than voriconazole for topical treatment of filamentous fungal keratitis, according to new research presented by N. Venkatesh Prajna, DO, chief of the cornea clinic at Aravind Eye Hospital in Madurai, India, in his presentation at the 2014 American Academy of Ophthalmology meeting.



Photo: Marc B. Abelson MD

A fungal keratitis case in the setting of a corneal transplant. Notice the purulent infiltrate along the margins of the cornea, as well as marked conjunctival hyperemia.

A double-masked multicenter randomized clinical trial compared the efficacy of antifungal medications voriconazole and natamycin in the treatment of filamentous fungal keratitis. *Fusarium* was the most common organism detected (40% of patients), followed by *Aspergillus* (17%).

Of the 323 subjects, 161 were

treated with 1% voriconazole and 162 were treated with 5% natamycin. The topical drugs were applied topically every hour during waking hours until re-epithelialization, then four times per day for three weeks.

Eyes that received natamycin therapy displayed better visual acuity at three months and were less likely to have perforation or require penetrating therapeutic keratoplasty. This trend was more pronounced in *Fusarium* cases.

The results of this research suggest that natamycin is the better single-agent treatment for filamentous fungal keratitis when compared to voriconazole; in fact, “monotherapy with topical voriconazole cannot be recommended for filamentary fungal keratitis,” Dr. Prajna concluded.

The researchers note individual susceptibility exists for fungal organisms, much as it does for bacteria, so therapy should be tailored accordingly. Also, “keep in mind there are penetration issues initially and toxicity concerns with prolonged therapy required in mycotic infection,” said Joseph Shovlin, OD, who was not involved in the research. “In recalcitrant cases, subconjunctival injections of fluconazole and intrastromal injections of amphotericin B are helpful.” **RCCL**

IN BRIEF

- A new noninvasive technique to **measure corneal elasticity** could help diagnose keratoconus and other corneal diseases. Published in the October 2014 *Journal of the Royal Society Interface*, this method uses optical coherence tomography (OCT) to **acoustically stimulate the cornea** and record nanoscale images of the movement at high speed and resolution, creating a new technique called **OCT vibrography**. These images provide information on corneal material parameters without interfering bias from corneal thickness or IOP that may help ECPs customize corneal treatments as needed.

- A study in the *British Journal of Ophthalmology* suggests **Demodex infestations may be more common among dry eye patients** without blepharitis than previously thought. When comparing *Demodex* infestations found using *in vivo* confocal microscopy (IVCM) versus classic eyelash depilation, both identified 100% of the mite infestations among patients with anterior blepharitis (n=18). However, IVCM found 60% of the infestations among dry eye patients without blepharitis (n=22) and 12% among healthy subjects (n=8), while depilation found only 50% and 0%, respectively. These results suggest **current clinical methods may be missing Demodex** in dry eye patients who present without possible infestation indications and otherwise healthy patients.

- A single thermodynamic **LipiFlow treatment applied to the meibomian glands may benefit patients in the early stages of MG dysfunction**, with clinical improvement persisting for up to six months, according to a small prospective trial in the journal *Cornea*. Reduced subjective symptoms and improved objective dry eye parameters (e.g., expressible glands, secretion score, lipid layer thickness) were found in 26 MGD patients examined before and six months after a single in-office treatment.

The extent of MG atrophy may correlate with treatment response—symptomatic **improvement was better in patients with less atrophy**, and no improvement in atrophy was noted after the therapy.

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Should Your Patients Purchase Contact Lenses Elsewhere?

Watch out for third-party contact lens sellers attempting to gain your patients' business.

Now that I have your attention, I'll attempt to answer. Third-party sellers *want* your patients to buy lenses from them, and they're riled by recent steps some manufacturers have taken on unilateral pricing policies.

What is unilateral pricing and how has it evolved over the years? In a unilateral pricing policy (UPP), the manufacturer independently (without agreement from resellers) announces a minimum resale price for a product and refuses to further supply a reseller that chooses to sell a product below that price.^{1,4} The manufacturer is not setting a retail price, but rather is establishing a minimum retail price limit. This policy is designed to encourage retailers to provide patients/consumers with a high level of personalized service, something eye care professionals (ECP) do well.^{1,3,4}

In 2007, the Leegin case rendered a decision that clarified a UPP as the only way a manufacturer can directly influence a reseller's retail price without subjecting itself to liability for price fixing.^{3,5}

There are two ways in which a purely vertical minimum retail price maintenance (RPM) agreement might be unlawful under federal "rules of reason," however:³ (1) A dominant retailer might consider RPM to forestall innovation in distribution of the product that decreases its cost, or (2) a manufacturer with market power might use RPM to give retailers an incentive not to sell the products of smaller rivals or new entrants.

Anticompetitive minimum RPM can also result from collusion or conscious parallelism in concentrated industries. Most states already try to codify their laws into judicial interpretations of analogous federal law. But, federal law is not the only source of antitrust claims.^{1,3}

UPPs AND DOWNS

A debate continues as to whether or not the new pricing policies employed by several major manufacturers are good or bad for consumers. Both sides provide cogent and rational points in their favor.

There are conceivable benefits for consumers/patients. Unilateral pricing inhibits "free-riding"—when the retailer sells discounted lenses to consumers after the ECP provides the information that leads to the purchase decision, including benefits of one brand over another and how to properly maintain and care for the product. Other benefits include inter-brand competition and potential to bring new products to market.¹ This allows resellers to justify the time and effort for services needed to introduce a new product.

One downside for consumers: prices may be higher in some situations than would have otherwise been charged. Also, anti-competitive outcomes are possible.^{1,5,6}

This past summer, a Senate hearing on pricing policies and competition pitted manufacturers and the American Optometric Association against groups representing alternative sources for lens purchases.

Both sides provided information on consumer centered issues, including the new pricing policies.²

Among other points, the representatives argued that UPP is another manufacturing tactic to keep patients dependent upon practices. Personally, I'm not sure how this can be interpreted as anti-competitive. Once again, we are made out to be the bad guys for offering both products and services in our practice.

I think a counterargument for protection by ECPs could be made. Online businesses have less money tied up in real estate and sometimes don't collect state taxes.³ Especially with the introduction of new products, alternative sources for contact lens sales could actually be viewed as a "free rider."^{1,3} Additionally, ECP are professionals—we are better equipped to help patients acclimate to their new lenses.

Of course, regardless of where our patients choose to purchase lenses, we should continue to educate them on new products under unilateral pricing policy and market those products as best we can with confidence from our practice. I suspect despite all the scrutiny, unilateral pricing is here to stay. **RCCL**

1. Eiden SB, Kassalow J: Impact of unilateral pricing policies. *Contact Lens Spectrum*. 2014; 9:36-40.

2. www.judiciary.senate.gov/meetings/procon-policies-and-competition-in-the-contact-lens-industry-is-what-you-see-what-you-get

3. Lindsay MA: Resale price maintenance and the world after Leegin. *Antitrust*. 2007; 22(1).

4. en.wikipedia.org/wiki/Unilateral_policy

5. www.kansas.com/news/business/biz-columns-blogs/business-perspectives/article1090137.html.



Digital World, Ocular Fatigue

Electronic device use is growing exponentially. Are you taking this into account when discussing contact lenses?

Now more than ever, digital devices are an integral part of our daily lives. Many of your patients likely spend their workdays in front of a computer, supplemented by use of handheld devices such as smartphones or tablets throughout the day. As such, it is imperative for you to take the time to address this clinically. Dry eye and discomfort at the end of the day due to digital eye fatigue is a common and growing complaint, and especially so in contact lens wearers.

Affecting children to emerging presbyopes most acutely but also advanced presbyopes as well, device-related eye fatigue will soon become one of the most important factors we address in our practice. Our visual world is changing rapidly and we need to stay on top of it. In this column, we will address some of the ways to help your contact lens patients see the best and stay comfortable in their lenses.

HOW MANY HOURS?

Start by asking all your contact lens patients how many hours they sit in front of a computer. Mid-day discomfort is a symptom happening more frequently with decreasing blink rates and increasing meibomian gland dysfunction. Aside from just standard daily computer use, it is important to know how much time, on average, our patients (both children and adults) spend in front of smaller screens like those found on smart-

phones or handheld gaming systems. Contact lens comfort during such activities must be addressed at every visit.

Asking about computer or digital device usage enables eye care professionals to discuss options like daily-replacement contact lenses, high-quality silicone hydrogel contact lenses and any prescription products or OTC drops that could help. It also gives us the opportunity to discuss computer and device usage best practices like taking visual breaks throughout the day and having a good pair of back-up glasses. Lastly but by no means insignificantly, these discussions often reveal near vision problems that can transition into a conversation about multifocal contact lens options.

TAILOR THE PROCESS

Customize the contact lens fit by choosing a design, material, modality and solution (if needed) that provides ideal patient comfort. Although comfort is difficult to predict sometimes, choosing a lens that maintains its hydration will help mitigate digital eye fatigue. Many of the newer materials and designs have improved hydration, reducing end-of-day discomfort.

Water content, important though it may be, is not the sole determinant of comfort, as contact lenses also vary in modulus, lubricity, oxygen permeability and edge design. All of those factors, along with the patient's ocular health and environment, influence the patient's perception of comfort with contact lens wear.

Don't forget to identify patients' occupations, hobbies and daily visual requirements. This will also aid in properly identifying their visual needs and discussing proper expectations ahead of time. If you are fitting a multifocal lens for children or adults, you can also customize the multifocal lens design to the patient's daily visual tasks. By successfully satisfying their visual needs, you will inevitably gain the respect of the patient and develop an ambassador for your practice.

EDUCATE YOUR PATIENTS

Accommodation is a somewhat difficult scientific concept to discuss with your patients. Use visual aids to explain the usual process and how it functions as we look at our computers and other devices. This will especially help your patient understand if you need to fit them with multifocal contact lenses.

EARLY PRESBYOPIA MAY FOOL YOU

Early presbyopia presents a challenge in that many patients may complain of distance blur or end-of-day eye discomfort. Accommodative fatigue is a major factor in these symptoms. It is important to educate the patient on the presbyopic process and the options available with contact lens wear. Many patients do not realize that multifocal contact lenses are even an option and that they will still be able to wear contact lenses for a long time into the future—as long as they want. Additionally, with

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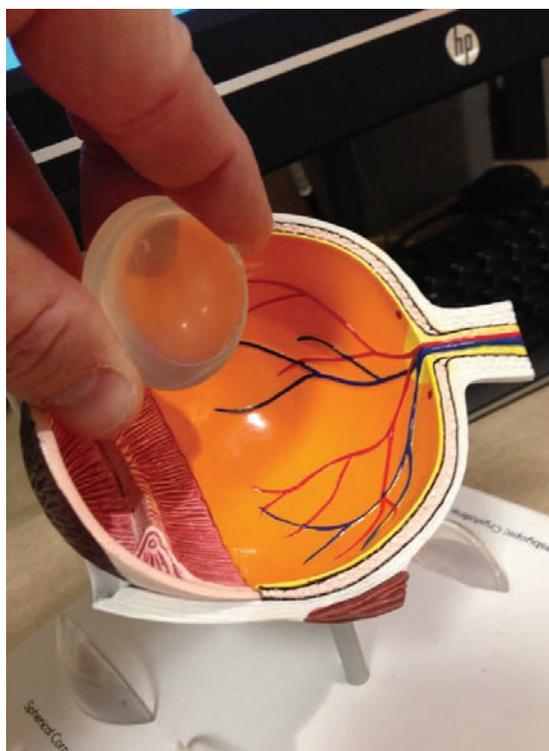
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the launch of many newer one-day multifocal lenses, patients can satisfy visual and comfort complaints at the same time, as the advantages of daily disposal help to reduce complaints of discomfort that might otherwise contribute to dissatisfaction. Put another way: don't give the early presbyope any more reasons to be disenchanted.

Prepare your patients by educating them about the onset and progression of presbyopic vision symptoms and how your practice can handle future near vision problems. Many will return and even tell you they are ready to try this new multifocal technology. There is a wide array of multifocal choices for patients ranging from emerging presbyopes to even the most advanced patients, including the presbyopic astigmat.

CASE IN POINT

Kevin, a 41-year-old emerging presbyope, was complaining of discomfort and distance blur. He spends 10-12 hours per day using a computer or other digital device and has found himself taking his lenses out earlier and earlier in the day. He currently wears a -3.50D monthly disposable lens in both eyes and has worn it for years.



Visual aids will help the patient understand complex processes like accommodation.

Following a discussion of the visual effects of presbyopia and options to consider, he was fit in a one-day multifocal contact lens design. These lenses were not only more comfortable, but his vision was improved and he loved the convenience of daily disposability.

Being confident and proficient in satisfying your patient's needs in the ever-increasing digital world is critical to the success of your contact lens practice. Many newer lens designs provide good optics and address contributors to lens discomfort, and should be considered as a means to grow your practice. **RCCL**



A Clear View of Multifocal Contact Lens Optics

By Pete Kollbaum, OD, PhD, and Arthur Bradley, PhD

Many patients abandon contact lenses at the onset of presbyopia due to the reduced quality of vision. Here's how to achieve the best vision possible and keep them wearing contact lenses.

Of the roughly 1.5 billion¹ presbyopes in the world, only an estimated 2.2%² wear multifocal or bifocal contact lens designs (*Figure 1*). Furthermore, many patients discontinue contact lens use as they enter presbyopia. With so many recent advances in lens technology, what accounts for this disparity?

Research has found that these trends likely result from patient concerns regarding cost, availability, comfort and visual clarity. Although comfort is believed to be one cause of contact lens abandonment, compromised vision may be an even larger one. In a recent survey of practitioners, 49% reported feeling that their patients dropped out primarily due to perceived shortcomings in the vision provided by currently available designs.³ This is inherently at odds with other studies that demonstrated “good” (i.e., 20/20) visual acuity at both distance and near with these designs.⁴ The latter, however, also reported much lower patient-reported quality of vision scores, which do not match this objectively measured acuity.⁴

The above result indicates that while refractive presbyopic contact lens designs “work” (i.e., allow the patient to see 20/20 at distance and near), they may not be providing

the overall quality of vision wearers often demand. Said another way, although achieving 20/20 is a good indicator of high quality of vision for a single-vision correction, it does not guarantee high quality of vision with presbyopic corrections. In this article, we outline several explanations for this seemingly paradoxical result—patients are not happy with 20/20 vision at distance and near—and how to use these ideas to enhance fitting success.

In clinical practice, our goal is to provide the best image quality or vision correction possible. With this in mind, the contact lens that theoretically would provide optimal image quality for a wearer would be one that completely corrects all optical deficits or aberrations of the wearer's eye. Though not readily commercially available, these lenses are known as “custom” contact lenses. For example, to optimally correct an eye with +0.4 μ m spherical aberration (SA), an aberration-correcting contact lens would have to contain -0.4 μ m SA (an amount equal in magnitude, but opposite in sign, to the eye).

However, for a presbyope, these lenses only provide optimal image quality at one single viewing distance. The presbyopic patient requires lenses with slightly more complex goals—namely, to expand

the depth of focus of the presbyopic eye or allow the presbyope to see at more than one viewing distance with the highest image quality possible. Several optical techniques are often employed to accomplish this, including refractive lenses, diffractive lenses, “accommodating” lenses and monovision. Each have their own merits, but the current discussion will focus on one of the most common contact lens optical designs: refractive multifocal lenses.

MULTIFOCAL CONTACT LENS DESIGN PRINCIPLES

Unlike in multifocal (progressive) spectacle lens designs, which contain a vertical power gradient from which, with eye and head rotation, the patient can *sequentially* select

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Dr. Bradley is a Professor of Optometry and Vision Science at IU, and runs a visual optics research lab there. His interests are centered around visual perception and the impact of the eye's optics on visual function.

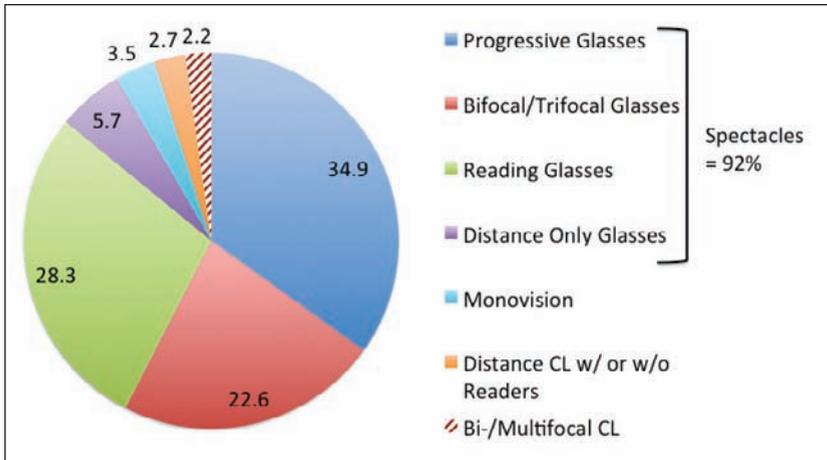


Fig. 1. A pie chart representing the percentage of presbyopic-age individuals who use various vision correction options.

the power appropriate to focus the target distance, most multifocal contact lenses employ a concept called “simultaneous image” (sometimes inappropriately called “simultaneous vision”). These contact lens designs also contain power gradients that either change radially or meridionally across the lens,⁵ but unlike presbyopic spectacles, the multiple powers contained in multifocal CLs *simultaneously* image targets. For example, the center of a multifocal contact lens may contain an optical power aimed at focusing light when the wearer views at “distance” (CD or Center Distance), or when the wearer views at “near” (CN or Center Near), but the surrounding optics create multiple images that would be in focus at other viewing distances.

MULTIFOCAL CONTACT LENS DESIGN LIMITATIONS

The optical structure of all simultaneous image multifocal designs, as the name implies, leads to the combination of focused and defocused images appearing simultaneously at all times when viewing either distant or near targets. This can be seen in the simulated retinal image of *Figure 2*, which depicts

the focused image corresponding to light passing through a “distance powered” area of the lens with the wearer viewing at distance; the defocused image obtained through the “near powered” area of the lens while the wearer remains looking at distance; and the result of these two images when the wearer simultaneously views through both of these areas of the lens (i.e., multifocal).

The decrease in perceived quality of vision reported by patients with simultaneous image multifocal lenses is most likely a direct result of the unavoidable presence of a defocused image in the combined multifocal image (*Figure 2*). The presence of these defocused images creates two primary changes in the multifocal retinal image: reduced contrast and a visible “ghost.” As can be seen in the simultaneous image quality simulation of

Figure 2, small letters can be readily visible, but the overall contrast of the image is decreased and the defocused image can clearly be seen.

The effectiveness of these simultaneous image designs becomes limited by a few key optical principles. Specifically, the gradient power change of multifocal lenses from their center to periphery, which is designed to increase the depth of focus of the wearer, is most commonly a form of SA. Although nearly all single vision contact lenses also contain SA,⁶ multifocal lenses typically contain higher magnitudes of SA, with “higher add” designs containing the most.

Unlike the custom lens described above, which aims to correct the eye’s optics, in order for a multifocal lens to effectively expand the depth of focus of the presbyopic wearer, some level of residual eye plus contact lens SA is necessary. For example, if a patient’s eye did not have any SA, and a CN contact lens with SA (e.g., $-0.3\mu\text{m}$) was placed on it, the expected resultant eye plus lens SA would be $-0.3\mu\text{m}$, which might be expected to sufficiently expand the wearer’s depth of focus (*Figure 3*, page 10, top row).

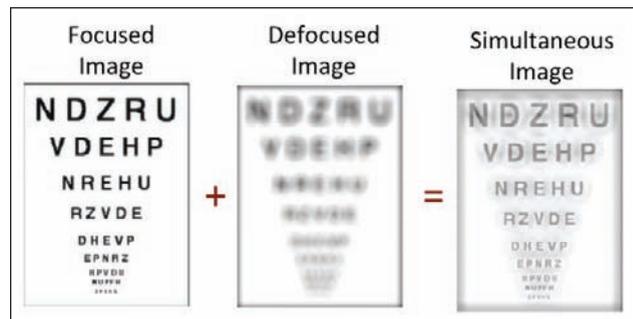


Fig. 2. The simulated retinal image of a typical letter chart of a well-corrected eye while viewing at distance through an optical zone containing the appropriate distance power (left panel); this same eye while viewing at distance through the optical zone containing the (defocused) near add power (middle panel); and the combined resultant of these two when the eye views at distance simultaneously through the distance and near powered optical zones as would occur in a simultaneous image contact lens (right panel).

A CLEAR VIEW OF MULTIFOCAL CONTACT LENS OPTICS

Interestingly, most commercially available multifocal contact lenses are “center-near” (CN) designs. These have their most plus/least negative power at the lens center and least plus/most negative power at the periphery, and induce negative SA. Most human eyes, however, contain significant levels of positive SA.⁷⁻⁹ Therefore, on average, it is possible the eye may contain positive SA (e.g., +0.3 μ m), while the CN lens may contain a similar level of SA, but opposite in sign. In such a case, the multifocal CL does not generate a multifocal eye plus lens, but rather leaves the presbyopic eye with zero eye plus lens resultant SA and a good optical correction (at one single viewing distance), albeit not with an expanded depth of focus (Figure 3, bottom row).

Obviously, any level of eye plus lens resultant SA may in itself degrade image quality. For example,

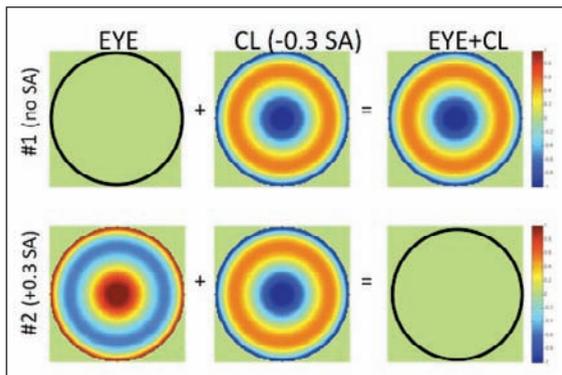


Fig. 3. The top row depicts an optically perfect wavefront corresponding to a hypothetical aberration-free presbyopic eye (left); the wavefront of a center-near soft multifocal contact lens with -0.3 μ m SA (middle); and the wavefront representing the sum of these two (right), providing a resultant eye plus contact lens residual amount of SA.

The lower row depicts the wavefront of a hypothetical presbyopic eye with +0.3 μ m of inherent SA (left); the wavefront representing the same center-near multifocal contact lens with -0.3 μ m SA (equal in magnitude, but opposite in sign to that of the eye) (middle); and the resultant optically-perfect wavefront representing the sum of the eye plus contact lens, leaving the eye well-corrected, but no residual SA aimed to expand the depth of focus of the wearer (right).

Figure 4 shows a simulated retinal image of a fully corrected eye with no aberration and with -0.4 μ m residual SA as might occur with a CN lens. Notice the decrease in simulated perceived image quality caused by the SA. Furthermore, a contact lens correction may also mislocate on the eye relative to the pupil center. This mislocation of a correction that contains spherical defocus and SA induces other aberrations, such as prism and coma, which may further degrade image quality.



Fig. 4. The simulated retinal image of a typical letter chart of a sphere- and astigmatism-corrected presbyopic eye with no SA (left); the same corrected eye wearing a hypothetical center-near multifocal contact lens with -0.4 μ m SA (middle); and the same eye wearing the same contact lens, but when the multifocal contact lens is decentered 1mm on the eye, inducing other aberration (i.e., coma) (right).

This induction of other aberration is in direct proportion to the amount of decentration and the amount of spherical defocus and SA contained within the lens.¹⁰ Specifically, decentration of a lens with higher levels of SA will generate higher levels of induced coma and poorer image quality. The right panel of Figure 4 demonstrates the simulated retinal image of the same SA-containing lens shown in the middle panel, when decentered 1mm. Notice the distinctly worse simulated perceived image quality due

to the decentration-induced coma aberration. Such dramatic changes in image quality are not associated with decentration of monofocal lenses, and the magnitude of this decentration effect is proportional to the level of SA contained within the contact lens.

MINIMIZING LIMITATIONS

The principle described above provides insight that may be used to enhance practitioner success when fitting multifocal lenses. Specifically, in order to minimize the impact of multifocal lens decentration, lower levels of SA must be used. However, lowering the SA level, reduces the multifocality of the lens. This apparent “Catch-22” suggests that to achieve a desired level of multifocality in the eye plus lens combination, while at the same time minimizing sensitivity to decentration, patients should be fit with multifocals that add to, rather than subtract from the inherent SA of the eye.

For example, assume that 0.4 μ m SA has been found necessary for an optical design to effectively expand

the depth of focus, and that the sign of this SA does not matter (e.g., positive or negative will have the same effect), and that our eye has roughly $+0.2\mu\text{m}$ SA (as might commonly occur in a presbyopic eye).⁷⁻⁹ One option to meet the necessary goal of $0.4\mu\text{m}$ eye plus lens SA is to supplement the $+0.2\mu\text{m}$ SA in the eye with $+0.2\mu\text{m}$ SA in a center-distance multifocal contact lens.

In this case, the aberration that is induced within the contact lens is minimized, as well as the aberration induced when this lens decenters 0.5mm inferiorly and temporally on the eye. In turn, both of these together maximally preserve the simulated image quality of this eye plus lens (Figure 5, left panel). Alternatively, however, if a center-

near contact lens is used to achieve the goal, $-0.6\mu\text{m}$ SA is required to achieve the necessary magnitude of $0.4\mu\text{m}$ eye plus lens SA. In this case, notice that, in the presence of the same on-eye lens decentration, the simulated image quality is much reduced (Figure 5, right panel).

The above argument implies multifocal corrections can be improved by measuring/knowing the aberration structure of our patients' eyes and the contact lenses we aim to use. Practically speaking, however, this strategy requires specialized equipment and may be time consuming. Therefore, a surrogate approach could be used based on population averages and published knowledge of lens designs. Because all presbyopic eyes may have

significant positive SA,^{8,9} consider using an aspheric CD design to add extra positive SA to the eye. With this small amount of added positive SA, we aim to reduce the sensitivity to lens decentration, while still providing sufficient expansion of their depth of focus.

If this approach does not work, the eye may not be "average," and it may have inherent negative SA. In this case, a low aspheric CN design may improve performance. Alternatively, if this approach does not work, this eye may have low amounts of SA altogether. In this case, a possible approach is to try a "higher add" design with increased levels of SA or to combine low amounts of defocus

with low amounts of SA.¹¹

In the future, it is hoped more contact lenses that use these design concepts will become available. For now, however the current report provides some insight of how to best use currently available designs to enhance fitting success. RCC

Disclosure: Drs. Kollbaum and Bradley have received research funding from several industry partners, including Alcon, Bausch + Lomb, CooperVision and Vistakon. They also hold a patent application (US Patent Application 13/496,613) related to some of the concepts discussed in this article.

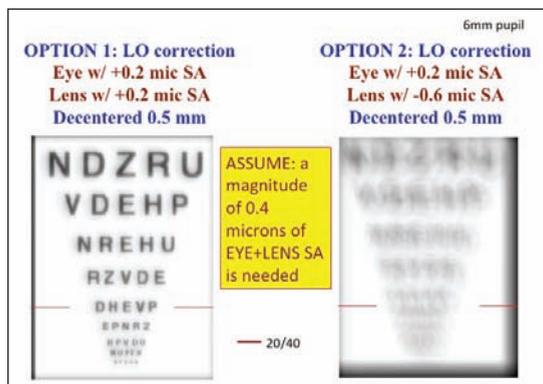


Fig. 5. Assuming it has hypothetically been determined that a magnitude of $0.4\mu\text{m}$ of resultant eye plus contact lens SA is necessary to expand the depth of focus of a presbyopic eye that has $+0.2\mu\text{m}$ inherent SA, two alternative solutions to this goal are described.

One option to meet the goal of $0.4\mu\text{m}$ eye plus lens SA is to supplement the $+0.2\mu\text{m}$ SA in the eye with $+0.2\mu\text{m}$ SA in a center-distance multifocal contact lens. In this case, the aberration that is induced within the contact lens is minimized, as well as the aberration induced when this lens decenters 0.5mm inferiorly and temporally on the eye, in turn maximally preserving the simulated image quality of this eye plus lens (left panel).

Alternatively, however, if a center-near contact lens is used to achieve the goal, $-0.6\mu\text{m}$ SA is required to achieve the necessary magnitude of $0.4\mu\text{m}$ eye plus lens SA. In this case, notice that, in the presence of 0.5mm inferior-temporal on-eye contact lens decentration, the simulated image quality is much reduced (right panel).

- Holden BA, Fricke TR, Ho S, et al. Global vision impairment due to uncorrected presbyopia. *Archives of Ophthalmology*. 2008;126(12):1731-1739.2. Opticourier 2006; www.opticourier.com/webmagazine/2006/02feb/content/contact_lenses/index.asp. Accessed March 1, 2006.
- Chamberlain P, Proclear 1 Day Multifocal: A refreshing perspective for the multifocal lens wearer. Paper presented at: BCLA2012; Birmingham, England.
- Richdale K, Mitchell GL, Zadnik K. Comparison of Multifocal and Monovision Soft Contact Lens Corrections in Patients With Low-Astigmatic Presbyopia. *Optometry & Vision Science*. 2006;83(5):266-273. 210.1097/1001.opx.00002160.98.0000262165.0000216034.
- de Gracia P, Dorronsoro C, Marcos S. Multiple zone multifocal phase designs. *Optics letters*. 2013;38:3526-9.
- Kollbaum PS, Bradley A, Thibos LN. Comparing the Optical Properties of Soft Contact Lenses On and Off the Eye. *Optometry & Vision Science*. 2013;90(9):924-936. 910.1097/1001.opx.0000434275.0000493435.da.
- Thibos LN, Bradley A, Hong X. A statistical model of the aberration structure of normal, well-corrected eyes. *Ophthalmic and Physiological Optics*. 2002;22(5):427-433.
- McLellan JS, Marcos S, Burns SA. Age-Related Changes in Monochromatic Wave Aberrations of the Human Eye. *Investigative Ophthalmology & Visual Science*. May 1, 2001 2001;42(6):1390-1395.
- Applegate RA, Donnelly IIIWJ, Marsack JD, Koenig DE, Pesudovs K. Three-dimensional relationship between high-order root-mean-square wavefront error, pupil diameter, and aging. *J. Opt. Soc. Am. A*. 2007/03/01 2007;24(3):578-587.
- Guirao A, Porter J, Williams DR, Cox IG. Effect of rotation and translation on the expected benefit of an ideal method to correct the eye's higher order aberrations. *J. Opt. Soc. Am. A*. 2001;18(5):1003-1015.
- Zheleznyak L, Sabesan R, Oh J-S, MacRae S, Yoon G. Modified Monovision With Spherical Aberration to Improve Presbyopic Through-Focus Visual Performance. *Investigative Ophthalmology & Visual Science*. May 1, 2013 2013;54(5):3157-3165.



CHANGE IS GOOD: ENCOURAGING THE SWITCH TO MULTIFOCALS

Presbyopes can be apprehensive about moving to multifocal contact lenses. How should you address their concerns?

By Glenda Secor, OD

Humans are naturally resistant to change. Whether it's simply switching to a new brand of product or moving to a different country, the majority of us experience some level of discomfort when our circumstances change, in part due to perceived loss of control and uncertainty regarding the future.

Contact lens patients affected by presbyopia face such uneasiness. Often for years, these patients see beautifully using the same contact lens product line. But as age and time catch up with them, contentment with their contact lenses diminishes as the advance of presbyopia intrudes upon their daily lives. Patients often become caught between an inertia of habit that keeps them committed to the lenses they are familiar with and the frustration of presbyopia's inevitable effects.

As practitioners, our ability to address patients' concerns regarding new modalities is a unique opportunity to assuage disenfran-

chised patients and smooth their transition to multifocal lenses. The words we use are powerful and our enthusiasm for new products enhances our ability to successfully address or avoid pitfalls. Factors such as price, visual compromise, adaptation period and presbyopic progression over time are all triggers that can lead to patient dropout. Having a good strategy to help keep these valuable patients involved in the practice is key.

IF THE PRICE IS RIGHT

Many of us are guilty of jumping to conclusions about the contents of our patients' pocketbooks, and how they choose to spend it. Multifocal lenses are premium products and the professional skill needed to get the best outcome requires a fee commensurate with the service provided. The offer of a "free" trial pair usually includes a comprehensive eye examination and the potential for a "fitting and follow-up" fee if the decision is made to move forward with the modality.

An up-front discussion can help reduce any misunderstanding if fees appear unexpectedly at the conclusion of a fitting process. Presbyopic patients are usually the most financially stable portion of our patient population, as they're typically at the peak of their career earnings, and are usually willing to pay the additional expense when the outcome results in increased convenience and less visual compromise. If needed, however, part-time use, especially with daily disposable multifocal lenses, addresses the convenience issues and high material costs associated with premium lenses.

ABOUT THE AUTHOR

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Dr. Secor has also been active with the American Optometric Association, most recently serving as Past Chair of the Contact Lens and Cornea Section.

NO COMPROMISE

Visual compromise is a huge issue for patients as they become presbyopic. Dryness and associated discomfort, redness and inconvenience are just some of the reasons patients drop out of using contact lenses, and these factors often worsen as patients grow older.

It is critical to listen to your patient's needs and concerns when fitting multifocal contact lenses. In addition to setting realistic expectations, identifying individual preferences, whether occupational or social, helps patients understand the rewards and limitations of multifocal lenses.

All current soft multifocal contact lenses are based on simultaneous vision designs—when both distant and near images are seen at the same time. In this case, the brain must learn to suppress the

ing the vision for the preferred task will enhance the experience and reduce compromise. However, dominance does not always dictate a preferred distance. Listening again to the individual needs of patient expectations can guide your adjustments.

It is easiest to start with good distance acuity and adjust the near as needed. This builds enthusiasm and confidence in the modality for patients and allows for easier adjustments at future follow-up visits. Avoid adding extra minus power anywhere, as any additional distance power often compromises the near vision.

Small incremental alterations in the parameters of multifocal contact lenses can make enormous changes in function for patients. This is especially true with aspheric designs—a 0.25D change in plus

as cell phones serve as good markers when deciding how to adjust parameters. Encouraging full blink excursion is critical with prolonged use of digital devices. This keeps the meibomian glands “pumping” efficiently.

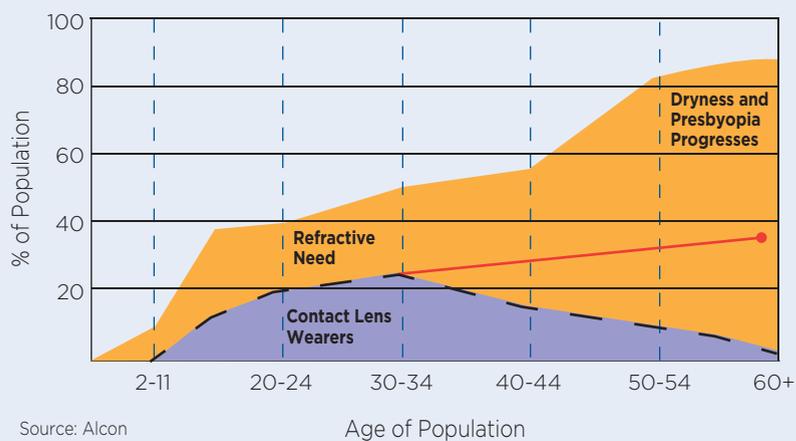
The visual compromise that occurs with presbyopia can be addressed simply by allowing patients to experience multifocal contact lenses in their world and adjusting the parameters as needed to improve their experience.

THE ART OF LENS FITTING

The successful fitting of contact lenses employs a combination of knowledge and clinical experience with various lenses and the ability to respond quickly when change is required. Understanding a patient's needs and behaviors can reduce the adaptation period because your initial lens choice may improve your odds for success. And with a variety of wearing schedules and lens design choices now available, our toolbox of multifocal contact lenses has never been better.

Most manufacturers use lens designs based on some form of asphericity, with the majority having a center-near approach. Center-distant lenses and “lens system” approaches are also excellent choices for the right patient. Lens System designs use different corrections for each eye by incorporating different power rings for distance and near. Traditionally, the dominant eye is fitted with the distance-centered design and the non-dominant eye is fitted with the near-centered design. Early or emerging presbyopes may adapt quicker to the center distance design or two distance centered designs when using the lens system approach. Needing more near vision help is often easier to achieve with the center near/higher add powers. For those in the

Contact Lens Wearers, By Age



Contact lens wear declines as refractive need begins to dramatically increase. The red line shows a projection of the potential contact lens wearing population if dropouts could be eliminated.

image that is out of focus for the desired task. While this ability is not innate, it can improve with adaptation. Cortical adaptation may occur in a few days to a few weeks, depending on the patient. Knowing the dominant eye and emphasizing

power can have a profound effect in near acuity. Hyperopic presbyopes are incredibly grateful for multifocal designs, as their age-related vision loss is catastrophic for various distances. Binocular acuity testing and real world targets such

CHANGE IS GOOD: ENCOURAGING THE SWITCH TO MULTIFOCALS

middle of their presbyopic experience, having multiple add powers allows flexibility to personalize their visual experience by biasing one eye for their preferred distance.

Centration with any contact lens is critical, but it is imperative with multifocals. Since we are rarely able to modify curvature, changing the design is extremely helpful when needed. Additionally, extreme pupil size—either too large or too small—is likely to cause problems.

As a side note, many manufacturers offer fitting guides to assist you with starting points and problem solving. While you may have your own bias about ways to enhance vision, these guides can be great

to checking initial acuities allows settling time. Typical adaptation times vary from one to three weeks, with changes made at appropriate visits. Changing one variable at a time simplifies the process and makes judging the impact easier. The patient's vision will almost always improve when given adequate time for adaptation; not rushing this process will help prevent early abandonment.

However, if you have used all your clinical expertise, made appropriate lens changes and the patient is still less than “wowed” by the lens performance, be willing to abandon multifocals for their old modality. Though many patients

any contact lens trial enhances success exponentially, as contact lenses can exacerbate certain symptoms.

The newest generation of presbyopes, Generation X, are those born between the early 1960s and early 1980s. Their needs and expectations are unique to their generation and life experiences. They have always known technology as a tool to enhance their lives and their self-reliance and independence sometimes makes change even more difficult. Regardless, they resist being or looking old, and don't want to “become their parents” too quickly. So, this population is generally amenable to addressing their presbyopic needs using newer methods like multifocal contact lenses when the reality of compromise is not working. Additionally, early presbyopes require lower reading options and often can adapt easier than more mature presbyopes who are entering the multifocal lens market.

Flexibility and creativity with mature presbyopes is key to their success. Being willing to wear the lenses part-time, mix different brands or use additional over-spec-tacles for specific tasks enhances options. Additionally, this population has future opportunities for new options when available and unlimited referral potential when their experience is optimized.

Achieving freedom from glasses for both aesthetics and function will motivate many presbyopic contact lens patients to succeed with multifocals. However, for those that may have concerns regarding making the change, many options exist to cater to their specific needs. It is our responsibility as multifocal contact lens experts to allow patients the ability to try lenses; meeting their needs is both professionally and financially rewarding. **RCCL**

"MOTIVATION IS PROBABLY THE MOST CRITICAL VARIABLE IN THE FITTING PROCESS."

reference points to direct your decision-making process to reduce the adaptation period.

While visual acuity is important to success, it is not always the tipping point for patients. In fact, motivation is probably the most critical variable in the fitting process. Motivated patients are more willing to try the recommended designs, return for follow-up care and pay the financial cost of a new modality.

It's important to note that insufficient adaptation time may prevent a patient from adjusting to new technology when they otherwise would have succeeded. Waiting a minimum of 10 to 15 minutes prior

will want to stay with the new lenses when they perceive the benefit of binocularity and improved function, some may prefer their old ones. Often, unsuccessful patients will comment that they appreciate the chance to try something new and know that we will have new products next year to address more of their unmet needs.

PRESBYOPIC PROGRESSION

Age is unkind to ocular health. As our ability to accommodate decreases with age, so does our tear production, which can lead to ocular surface disorders such as dry eye. Addressing these issues prior to

Bausch + Lomb ULTRA® Contact Lenses with MoistureSeal® Technology

Taking Contact Lens Properties and Design to the Next Level for Best in Class Performance

by Greg DeNaeyer

KEEPING PATIENTS SUCCESSFULLY IN CONTACT LENSES is a challenge for every practitioner. The last technological advancement in frequent replacement silicone hydrogel contact lenses was in 2007 and unfortunately dropout rates have not improved since that time. The likelihood of contact lens discontinuation has remained steady. Ocular symptoms of dryness and discomfort have been reported as the primary reasons for dissatisfaction or discontinuation of contact lenses.¹ Contact lens patients who spend the majority of their work day on a digital device may be more susceptible to dehydration blur, ultimately resulting in decreased wear time or increased risk for drop out of contact lens wear.²

The Tear Film and Ocular Surface (TFOS) Society's recently conducted International Workshop on Contact Lens Discomfort (CLD) suggested questions regarding lens design that may help reduce CLD. Specifically, what contact lens material properties have the most influence on CLD? Are there advanced technologies in lens materials or design that could help reduce CLD?³

Successful contact lens wear requires a patient to have good vision and comfort while maintaining a healthy anterior ocular surface. Unfortunately a harmony of these requirements is not always achieved, which may lead to decreased wear time or discontinuation of contact lenses. Ultimately the physical properties of a contact lens are what we clinicians use to guide our decisions to prescribe a contact lens with the goal of providing a patient with a successful wearing experience. Our patients don't think of comfort and vision as distinct properties. They desire and we demand great comfort, vision, and health from their contact lenses. After 7 years of research and development, Bausch + Lomb has introduced a novel silicone hydrogel contact lens, Bausch + Lomb ULTRA® contact lenses with MoistureSeal® technology, to help deliver the best in class properties among the leading silicone hydrogels to provide exceptional comfort, vision and health in one contact lens for the first time.

BRAND	Dk/t	MODULUS	WATER CONTENT	ASPHERIC OPTICS
Bausch + Lomb ULTRA® contact lenses	163	70	46%	✓
ACUVUE OASYS	147	73	38%	
AIR OPTIX AQUA	138	102	33%	
Biofinity	160	82	46%*	✓

*Measured water content.

Fig. 1: Physical properties of the Bausch + Lomb ULTRA® contact lens and other leading silicone hydrogel lenses.

Best in Class Properties for Best in Class Performance

MoistureSeal® technology is how Bausch + Lomb ULTRA® (samfilcon A) contact lenses are able to achieve optimal physical properties. It is a breakthrough combination of a proprietary material formulation and manufacturing process that gives Bausch + Lomb ULTRA® its inherent wettability, lubricity, and excellent deposition resistance. MoistureSeal® technology is a unique 2-phase polymerization process not found with any other contact lens. The first phase integrates three silicone monomers whose combinations were chosen to optimize Dk and modulus. The silicone matrix is a unique combination of patented long-chain and short-chain silicone molecules.

The silicone component of Bausch + Lomb ULTRA® contact lenses was formulated using a mathematical modeling approach allowing researchers to predict interactions between various silicone monomers to optimize material properties including Dk, modulus, water content, and coefficient of friction (COF). The Dk/t of Bausch + Lomb ULTRA® is 163, which is the highest amongst leading monthly replacement silicone hydrogel contact lenses (Figure 1). Typically, as Dk is increased, the modulus increases and the water content decreases, which

REFERENCES: 1. Richdale K, Sinnott LT, Skadahl E, Nichols JJ. Frequency of and factors associated with contact lens dissatisfaction and discontinuation. *Cornea*. Feb 2007;26(2):168-174. 2. Kadence International. Exploring Contact Lens Drop-off. May 2013. 3. Jones L, Brennan NA, Gonzalez-Mejome J, et al. The TFOS International Workshop on Contact Lens Discomfort: report of the contact lens materials, design, and care subcommittee. *Invest Ophthalmol Vis Sci*. Oct 2013;54(11):TFOS37-70. 4. Hotelling A, Nichols W, Harmon P, Hook D, Nunez I. PVP content of a silicone hydrogel material with dual phase polymerization processing. *American Optometric Association Annual Meeting*; 2014; Philadelphia, PA. 5. Hook D, Taft S, Steffen R, Merchea M. Comparing the static and kinetic friction of unworn and worn silicone hydrogel contact lenses. *Association for Research in Vision and Ophthalmology annual meeting*. 2014.

may lead to a less comfortable contact lens wearing experience. However, the proprietary combination of silicone monomers that makes up Bausch + Lomb ULTRA® allows it to have a low modulus and high water content while providing excellent oxygen transmissibility. Figure 2 shows that Bausch + Lomb ULTRA® has one of the highest Dk/t and lowest modulus values as compared to other leading silicone hydrogel lenses. Recognizing that silicone materials are inherently hydrophobic, phase two of MoistureSeal® technology polymerizes a wetting agent permanently around the silicone matrix to provide inherent moisture and wettability.

The primary hydrophilic element of Bausch + Lomb ULTRA® is polyvinylpyrrolidone (PVP), a very effective humectant (a water loving polymer) that is used in eye drops and even some other contact lenses to improve wettability and moisture retention. MoistureSeal® technology builds PVP polymer around and throughout the silicone matrix from its precursor monomers. Bausch + Lomb ULTRA® is the only lens to use this approach of growing PVP around a matrix of silicone and thereby is able to achieve four times higher PVP concentration in Bausch + Lomb ULTRA® as compared to the market leading silicone hydrogel that also uses PVP as a wetting agent.⁴ The PVP allows the lens to have exceptional wettability, deposition resistance, and moisture retention. MoistureSeal® technology allows the Bausch + Lomb ULTRA® lens to maintain its high moisture levels during a full day of wear for the entire 30 day replacement schedule.

Coefficient of friction (COF) is becoming a popular metric to try and predict the comfort of contact lenses by manufacturers and researchers. In fact, the TFOS CLD report also recognized that COF may be an important contributor to contact lens comfort or may help to reduce the occurrence of lid wiper epitheliopathy (LWE). Bausch + Lomb ULTRA® has a dynamic and static coefficient of friction (COF) that is equivalent to or lower than other leading silicone hydrogel materials including senofilcon A and even the daily disposable material delefilcon A.⁵ More research is needed to understand the impact of COF on comfort, however the Bausch + Lomb ULTRA® lens has low COF even in a worn lens condition.⁵

Comfort, Health and Vision

Bausch + Lomb ULTRA® contact lenses also incorporate aspheric optics to control spherical aberration to help improve visual performance and reduce symptoms of glare and halos, particularly in low light environments. Spherical aberration may be inherent in the eye or induced by the contact lens itself. Bausch + Lomb ULTRA® showed the lowest residual spherical aberration compared to other leading silicone hydrogel lenses in an in-vitro study. Figure 3 shows the magnitude of residual spherical aberration present (assuming a +0.18 µm population average) after reduction provided by Bausch + Lomb ULTRA® as well as several other lens brands.

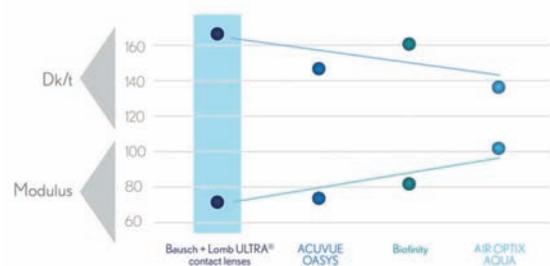


Figure 2: The relationship of Dk/t and modulus for various silicone hydrogel contact lenses. Bausch + Lomb ULTRA® has the lowest modulus and highest Dk/t among the leading silicone hydrogel lenses.

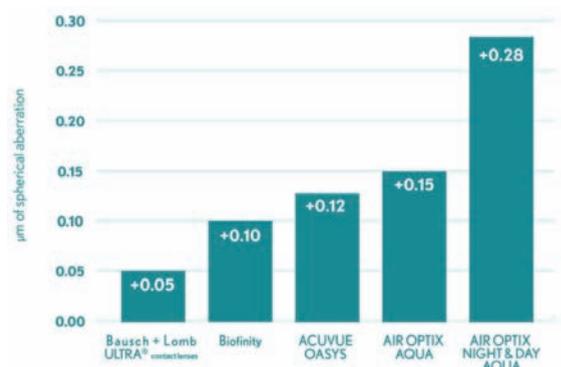


Figure 3: Amount of residual spherical aberration present (assuming a +0.18 µm population average) after the reduction provided by Bausch + Lomb ULTRA® as well as several other lens brands.

Edge Design

The edge design of a contact lens may also be an important driver of lens comfort.³ Bausch + Lomb ULTRA® was designed to have reduced mid-peripheral thickness and a tapered uniform edge profile to provide exceptional comfort. The thin edge allows for a smooth transition between the conjunctival tissue and the lens surface. Finite Element Analysis was used to optimize the mechanical stability that gives Bausch + Lomb ULTRA® optical stability and consistent fitting characteristics.

In Conclusion

Scientists at Bausch + Lomb have designed a silicone hydrogel lens with optimal physical properties for comfort, health and vision. Bausch + Lomb ULTRA® contact lenses with MoistureSeal® technology provide the best Dk/t, water content, modulus, and coefficient of friction that help deliver unsurpassed comfort and vision compared to the leading silicone hydrogel lenses. ■

No Patient



Left Behind

With a myriad of multifocals at our disposal, just about everyone is a good candidate for presbyopia correction of some kind.

By Patricia Keech, OD

When evaluating the pre-presbyopic contact lens patient, it's best to educate them on future decisions they will need to make as their eyes change over the next few decades. Try not to fit a multifocal or monovision lens before the patient truly needs it in their world, as they won't adapt as easily—let *them* tell you when they can't see their phone screen anymore.

WHICH IS BETTER: MONOVISION OR MULTIFOCAL?

A diagnostic session in the office will usually point you in the right direction regarding whether to prescribe monovision or multifocal lenses. First, try overplussing the nondominant eye just enough for good near function—if this is successful, the patient is likely a good monovision candidate. However, if the patient feels dizzy or notices an imbalance or significant difference in vision clarity between eyes, multifocal lenses may be a better choice.

For patients not yet wearing contact lenses, especially hyperopic patients or new presbyopes, offering a pair of multifocals to be worn during dilation to allow for frame

selection is a great way to demonstrate the positional independence of multifocal contact lenses. In other words, they can see up close in all viewing positions, not just in the reading position.

So, now that you have the patient's attention, the fitting process for new multifocal and monovision patients starts with acquiring a thorough knowledge of their needs and desires:

- What are their visual priorities? Are they planning to wear the lenses full-time or only part-time?
- What daily activities could affect their lens preference?
- Are dry eyes or tear film abnormalities an issue?
- Is the patient a keen observer or more laid back concerning visual needs? Jewelers need excellent near vision; teachers probably don't.
- How much astigmatism is there to be dealt with?
- How long do they use the computer or other electronic devices each day?

Stress to the patient that most—but not all—of their visual needs may be met, especially in cases of presbyopia after age 50, so they do not form unattainable expectations. For this reason, a “show and tell” using trial lenses is extremely valuable before proceeding with the

full diagnostic fitting process, as you can discern the patient's reaction to the new modality, and make minute adjustments after the initial adaptation. Emphasize to the patient that you are trying to find the *best* compromise for them. There is no perfect solution. In practice, most patients will achieve about 80% of their visual demands—and it is a process, with follow-up required.

As Keith Masnick, M.Optom., observed in the early days of multifocal contact lens fitting, “It doesn't always make sense; the numbers don't always work out as predicted.” Multifocal fitting is a highly pragmatic process. To be successful, the patient must first *use* the lenses.

A TALE OF FOUR PATIENTS

In this article, we will bypass the early, easy presbyopic fit. You know how to do that. But what

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Dr. Keech is in a group practice in Shoreline, WA. Previously, she was on staff at Group Health Cooperative of Puget Sound in Seattle and an assistant professor at Indiana University. A fellow of the AAO and a Diplomate of the Cornea and Contact Lens Section, she also served as a member of the Executive Council.



NO PATIENT LEFT BEHIND

about when a patient comes back one or two years later complaining their vision is blurry both up close and far away? Below are four sample cases. Although specific lenses are mentioned, the goal here is not to advocate for a particular lens but rather to walk through the process of problem solving. Many other products and approaches might work too—that's the point. It all depends on what each patient responds to.

• *Case 1: Modified Monovision.*

Many, if not most, soft multifocal patients eventually require modified monovision to obtain more working distance acuity. Modified monovision can be used with any lens design. The Biofinity Multifocal (CooperVision) is available in a dominant (center distance) and nondominant (center near) design, with a range of permutations and combinations of power available due to the specific add choices. I've had success with this lens in marginal dry eye patients and those who may have difficulty making the switch from hydrogel to silicone hydrogel materials. Some patients prefer the nondominant design in both eyes, while other prefer the dominant design in both eyes. (Don't forget to think outside the box to problem solve—channel our friend Keith!)

CooperVision also offers one of the few toric multifocal designs available, the Proclear Multifocal Toric DW. This is a progressive design available in both dominant and nondominant options in two base curves, with an add that can be specified up to +4.00. Custom cylinder powers up to -5.75 are also offered, with sphere powers up to +/-20.00 D. The main drawback to this lens is the low oxygen permeability due to the hydrogel material; to reduce the possibility

of tearing a lens, use lubricating drops before removal.

• *Case 2: Residual Astigmatism or the Slightly Irregular Cornea.*

P.P., a 53-year-old female computer systems analyst presented wearing monovision SCL with a toric lens in her near eye. She has a history of low corneal rigidity and possibly low grade keratoconus, although she is correctable to 20/25 with spectacles. She reported being unable to read her phone without over-the-counter reading glasses.

This patient was refit into the Purevision (Bausch + Lomb) multifocal high add in both eyes, regaining better near vision and retaining her good distance correction. Though the new PureVision2 multifocal has excellent optics and is a great first choice for those patients that require excellent acuity, I frequently use the older design in cases like this, or in cases of higher residual astigmatism, because it helps “mask” astigmatism and low grade corneal irregularities due to its modulus and low water content.

With this lens, proper prevention of contamination from exogenous oils should be emphasized, and good lid hygiene should be reviewed with all patients. As with all soft lenses, the initial insertion is more comfortable if you avoid touching the inside surface of the lens when removing it from the case or flatpack. Instead, allow the lens to float out of the case onto your finger, rather than fishing for the lens in the case and leaving a fingerprint on the inside surface.

• *Case 3: Aspheric Rigid Designs and the Borish Technique.*

Many of my translating or segmented rigid bifocals have at some point had cataract surgery, or shifted to an aspheric design. The new front surface aspherics gener-

ate far less spectacle blur than the older back surface aspheric options. These lenses are ideal for the rigid lens wearer with high visual demands.

M.P., a 61-year-old female hairdresser who is also a golfer, requires good intermediate vision for cutting hair. She started wearing rigid lenses over 40 years ago, and always has appreciated her better-than-20/20 vision. Her first experience with monovision was not good for golf, so she shifted to an aspheric front multifocal design, the Golden Eye AFM (Valley Contax). This process was suggested to me by the late Irvin Borish, OD, who said that when presbyopia becomes an issue with a GP wearer, try monovision in a larger diameter lens as you would use with a multifocal. If this method doesn't work, switch to a multifocal design instead.

Another modified monovision approach is to use an aspheric SV lens such as the Boston EO Envision (Bausch + Lomb) to enhance the depth of focus of both eyes. Keratoconus lens patients wearing an aspheric corneal lens reap the side effect of better near vision depth of focus than with a spherical design. I have also used the Rose K design as a multifocal lens in patients without keratoconus.

Dr. Borish also noted residual astigmatism has an increased blurring effect later in the course of presbyopia; that is, with reduced accommodation we are less able to compensate for any residual astigmatism, and eventually this will have a greater negative impact on visual acuity. So, patients who were initially tolerant of uncorrected astigmatism may require toric lenses as presbyopia progresses to obtain the best possible monocular visual acuity while remaining

in a monovision modality. This must be balanced, however, against the loss of depth of focus that occurs when residual astigmatism is reduced; that is, one usually under-corrects astigmatism in monovision for better working distance.

• **Case 4: Dailies and Meibomian Gland Dysfunction.** M.M., a 52-year-old computer jockey, had stopped wearing his monovision lenses due to inadequate visual performance and repeated marginal infiltrates resulting from a compromised tear film and chronic blepharitis.

For a patient who has crossed the threshold to the second half of their century, multifocals may take the place of formerly successful monovision designs. Given the plethora of meibomian gland dysfunction in this population and its effect on the tear film, a dailies design is ideal. One example, the Dailies Aqua Comfort Plus Multifocal (Alcon), comes in low, medium and high adds, and in my experience can mask up to 1.00D of astigmatism. Sometimes, a little bit of residual astigmatism can actually help the depth of focus at near.

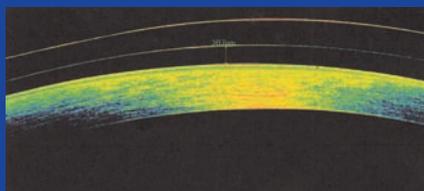
To find the best compromise for each patient, try over-refracting with flipper bars in 0.25D increments in a real-world setting. For distance, I have them look out the window and check them both binocularly and monocularly. Be sure to over-refract each eye individually, but also check their binocular distance vision and near point range. I usually explain to the patient that we can move their nearpoint range in and out, but it is more difficult to expand the range (unless the patient is comfortable with a modified monovision).

In this case, the patient was fit with a medium add Dailies Aqua Comfort Plus Multifocal in each

Fitting a Hybrid or Scleral Multifocal

By Stephanie L. Woo, OD

Hybrid and GP scleral multifocals are some of the newest options available for presbyopic patients. Both designs have great features that turn some of even the toughest patients into good candidates for multifocals.



• **Hybrid lens:** Let's say a 50-year-old presbyope who desires more freedom from glasses comes into your office wearing progressive addition lenses. Upon questioning, you find out the patient believes they are not a good candidate

for contact lenses due to their astigmatism. Hybrid lenses are a great option for astigmatic presbyopes because the gas permeable center of the lens can mask corneal astigmatism, while the soft skirt of the lens provides patients with good comfort. Hybrid lenses can be ordered empirically with keratometry values, refraction, add power and eye dominance. This can greatly reduce chair time, especially if the first set of lenses ends up being the pair that is finalized. Also, the warranty on hybrid lenses is excellent in the case of any exchanges or returns.

• **Scleral multifocals:** Patients with irregular corneas can also wear multifocals, if their practitioner deems them to be a good candidate. For instance, a patient with a corneal transplant who can see around 20/30 or better may be a good candidate for a scleral multifocal. Keep in mind scleral lenses do not move very much, so translating designs are not an option. Most scleral lens designs are aspheric in nature.

Patients with normal corneas can also benefit from scleral multifocals. Most of the designs have smaller diameters and are fit with less clearance (see the image above) than normal scleral lenses. Previous GP multifocal wearers along with prior soft lens wearers have both proven to be excellent candidates. In fact, I recently had a patient who had successfully worn GP multifocals for many years, but was interested in achieving slightly better comfort and reducing dry eye symptoms. I fit him into a scleral lens multifocal and he exclaimed, "This is best vision I have."

eye, despite having around -0.75 residual cylinder in both eyes, and was aggressively treated for the blepharitis and meibomian gland dysfunction.

In cases of a severely irregular cornea or high astigmatism, a rigid design may be best. For those patients unable to adapt to a corneal lens, scleral lens designs or hybrid lenses would be the next step (see "Fitting a Hybrid or Scleral Multifocal"). As one example,

SynergEyes now offers both the SynergEyes multifocal and the Duette multifocal and progressive designs, which offer better oxygen permeability. If you or the patient has difficulty removing an adherent lens, wearing latex gloves allows for easier removal—a useful tip from the late David Rosenbloom, OD, of Pittsburgh.

So, go ahead and jump right in! The possibilities are greater than they have ever been. 

**1 CE
Credit**(COPE Approval
Pending)

THE FINAL CUT: SURGICAL CORRECTION of Presbyopia

Are we close to replicating accommodation without compromise?

By Andrea Crabb, OD, and Ronald Krueger, MD

Presbyopia, the age-related loss of the ability to actively focus on nearby objects, is a frustrating yet unavoidable condition of the eye. The exact mechanism is not fully understood, but changes in the ciliary body, zonules, lens capsule and lens itself are known to play a role. Symptoms usually begin around age 40 (“My arms are too short”) and progress until all accommodative ability is lost, usually in the mid-60s.

Everyone who lives long enough eventually develops presbyopia; this inevitability emphasizes the demand for good treatment options. Non-surgical management techniques such as glasses and contact lenses are popular and effective, but have shortcomings.

Some patients cannot adjust to multifocal spectacle lenses and must deal with the inconvenience of constantly switching between single vision distance and reading glasses. Others are bothered by the psychological stress of aging, which is confounded by the idea of needing bifocals, especially a cosmetically unattractive lined bifocal. Contact lenses can cause

discomfort, exacerbate dry eye (a condition common in this older age group), and elevate the risk of potentially vision-threatening infections, such as corneal ulcers. Dexterity issues become more apparent with age, making it difficult for presbyopic patients to handle contact lenses. Also, patients with emmetropia or hyperopic presbyopia experience lens insertion difficulty from uncorrected near blur.

Advances in refractive surgery have led an ever-increasing segment of our patient population to seek spectacle and contact lens independence. Given its prevalence, effective surgical techniques to correct presbyopia are in high demand. The purpose of this article is to review current, new and investigational surgical solutions to presbyopia for the comanaging eye care professional.

PATIENT MANAGEMENT

Similar to the refractive surgeon, the comanaging optometrist faces the same challenges when dealing with the expectations of a premium IOL or refractive patient.

Often, patients seeking refractive surgery do not understand the challenges of treating pres-

byopia. Myopes have difficulty comprehending the sacrifice of nearsightedness at the expense of clear uncorrected distance vision. Hyperopes and astigmats often expect total independence from their full-time bifocal glasses, as relying on reading glasses defeats the purpose of refractive surgery. Additionally, the level of expense incurred can inflate visual outcome expectations. The optometrist and surgeon alike face the task of educating the patient and establishing realistic and achievable expectations. In general, a prudent approach is to under-promise and over-deliver.

Good patient selection is critical to clinical success. Dissatisfied patients often complain of decreased contrast sensitivity and photic

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(halos/glare) symptoms, both of which are confounded by underlying corneal or retinal conditions. Therefore, dry eye, an irregular cornea, corneal astigmatism greater than 1D or any signs of macular pathology (e.g., epiretinal membrane, macular degeneration), would likely disqualify a patient from premium IOLs or refractive surgery.¹ The ideal patient is motivated to be free from glasses and able to tolerate visual imperfection.

Current and experimental presbyopic surgical methods can be divided into three groups: replacement of the crystalline lens with a presbyopia-correcting intraocular lens (IOL), refractive surgery of the cornea or crystalline lens, and modification of the sclerociliary complex (*Figure 1*).¹

REPLACEMENT OF THE CRYSTALLINE LENS

Presbyopia-correcting IOLs are categorized as *multifocal* or *accommodative*. Multifocal IOLs correct presbyopia using the principle of simultaneous vision, in which incoming light rays are divided into variable focal points, creating multiple coexisting retinal images. The patient primarily perceives only the focused image of interest (either distance or near) and ignores the blur from the unfocused image.²

- **Multifocal IOLs** are categorized as either *refractive* or *diffractive*, based on lens design. A third, emerging category uses a concept called rotational asymmetry (examples include the LentisMplus from Oculentis and the FineVision IOL from Liege).

Refractive IOLs create several focal points with concentric zones of varying optical power. Since the aperture of each zone varies, image quality depends on pupil size, which is driven by light and ac-

commodation. The ReZoom (Abbott Medical Optics) is a refractive three-piece IOL with five refractive zones. Zones one (center), three and five focus distant images while two and four focus near images. The aspheric transition between zones provides intermediate vision while the near zones provide +3.5D of add power, which vertexes to +2.85D at the spectacle plane. The three distinct distance zones were designed to enhance distance vision in bright, intermediate and low light conditions. However, a small photopic pupil size may compromise near vision, given the lens's center distance design.²¹

Diffractive IOLs, on the other hand, incorporate the principle of diffraction, in which light slows and changes direction when it encounters an obstacle. The surface of a diffractive IOL is covered with microscopic ridges, called diffractive zones. Incoming light is directed towards various focal points based on the diffractive zone's ridge height and the light's wavelength. The amount of light directed to a focal point is related to the step height as a proportion of wavelength. For example, at a step height of one wavelength, all light is directed to the near focal point, while at a step height less than one wavelength, light is directed to the distance focal point.²⁻⁴

Diffractive IOLs are subdivided into two designs. *Apodized IOLs*

feature ridges that gradually decrease in height and spacing toward the lens periphery. As pupil size increases, more diffractive zones with smaller ridge heights are exposed, directing a larger proportion of light to the distant focal point, as described above. The AcrySof Restor (Alcon) is an IOL with a central apodized diffractive optic zone and refractive peripheral region. This design is believed to enhance distance vision in low light conditions, and offers an add power of either +4D or +3D, which vertexes to roughly +3.2D and +2.5D at the spectacle plane. A toric version of the Restor is currently available in Europe, but not yet approved in the United States.^{2,4}

In contrast, the ridges on a *nonapodized IOL* are of uniform height and spacing from the center to the periphery, which directs an equal amount of light to the near and distance focal points independent of pupil size. Therefore, nonapodized lenses, such as the Tecnis multifocal IOL (Abbott Medical Optics), may enhance low contrast near acuity, but the optics can induce significant halos at night.²

Overall, both apodized and nonapodized diffractive multifocal IOLs have largely replaced refractive IOL designs due to reduced glare and halos and the improvement of other performance factors.⁵

Release Date: November 2014

Expiration Date: November 1, 2017

Goal Statement: This course reviews various surgical techniques and implantable medical devices used to correct presbyopia. Both currently approved and investigational products are discussed.

Faculty/Editorial Board: Andrea Crabb, OD, and Ronald Krueger, MD

Credit Statement: COPE approval for 1

hour of CE credit is pending for this course. Check with your state licensing board to see if this counts toward your CE requirements for relicensure.

Joint-Sponsorship Statement: This continuing education course is joint-sponsored by the Pennsylvania College of Optometry.

Disclosure Statement: Drs. Crabb and Krueger have no financial disclosures relevant to this course.



SURGICAL CORRECTION OF PRESBYOPIA

• **Accommodating IOLs** fall into two categories: *single-optic* and *dual-optic*. Single-optic IOLs like the hinge-based Crystalens (Bausch + Lomb) alter image focal points through anterior movement of the IOL and changes in IOL architecture.⁶ In general comparison with multifocal IOLs, accommodating IOLs offer better contrast sensitivity and photic symptoms because incoming light is focused at a single focal point, similar to a monofocal IOL. The original Crystalens clinical trial, however, only reported about 1D of accommodation, so multifocal IOLs still provide stronger near power than current accommodating IOLs.

Various pseudo-accommodative factors can impact the accommodating IOL outcome—for example, modified monovision and pupil-dependent depth of focus. Capsular fibrosis can also interfere with the outcome by further reducing

accommodation, inducing IOL tilt and possible asymmetric folding at the haptic-optic junction. This phenomenon is known as the “Z syndrome” because of the shape of the distorted IOL.⁷

To enhance the range of accommodation, dual-optic IOL systems use two lenses, an anterior high plus lens coupled to a posterior minus lens. As the distance between the two lenses changes, the effective optical power of the system is altered. For example, the Synchrony IOL (Visiogen/AMO) consists of a +32D front optic connected by spring haptics to a posterior negative optic of variable power. The lens is not currently approved by the FDA and the manufacturer appears to have ceased development, but trials show an accommodative range of $3.22 + 0.88D$.⁸ Initial studies of the Synchrony system have also shown reduced posterior capsular opacification at-

tributed to the non-collapse of the capsular bag with the dual optic design.⁹ However, a larger incision is needed for placement, which can induce postoperative astigmatism.¹⁰

Currently, the only FDA-approved accommodative IOL is the Crystalens and its toric version (Trulign), but other accommodating IOL systems are in clinical trials or development. The Tetraflex (Lenstec), a flexible non-hinged single-optic accommodating IOL, is one such example currently pending FDA approval. This IOL has closed-loop haptics that are angled anteriorly 10° , causing the optic to flex and change curvature with accommodation. A study done on the comparison of functional reading ability provided by the Tetraflex and the Crystalens noted a higher proportion of patients could read 80 words per minute or more at print sizes as small as 20/25 with the Tetraflex.¹⁰

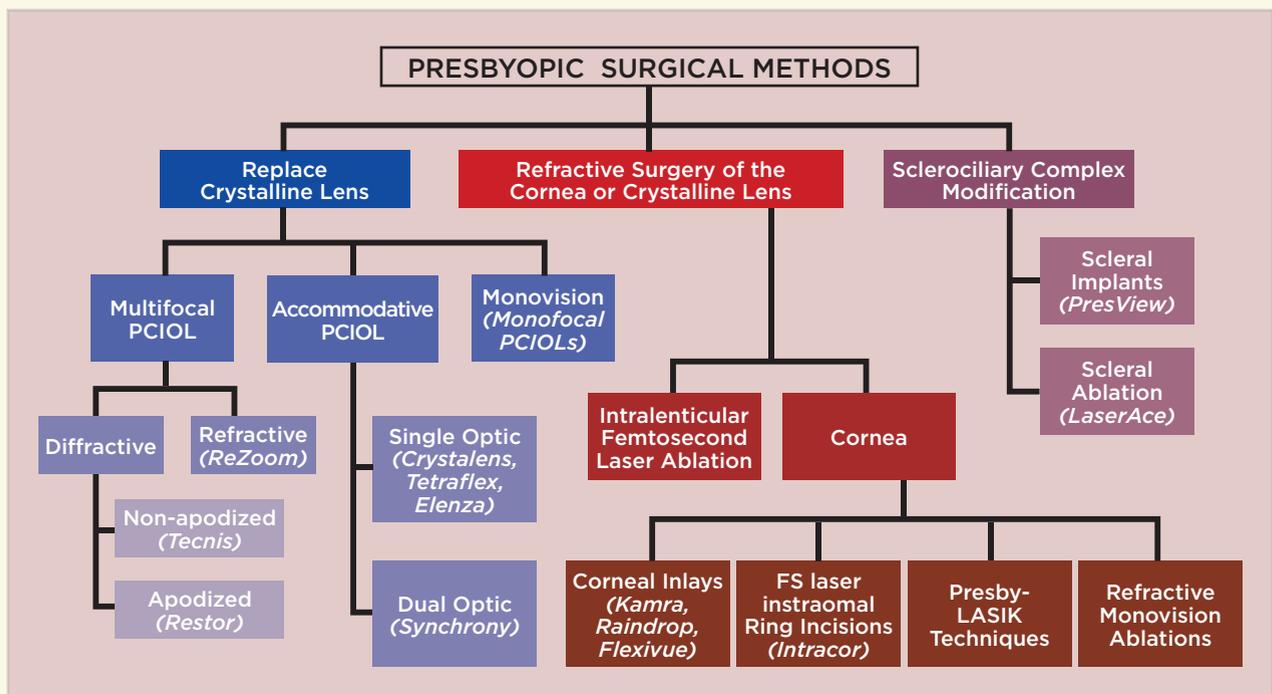


Fig. 1. Current and experimental presbyopic surgical methods can be divided into three groups: replacement of the crystalline lens with a presbyopia-correcting intraocular lens (IOL), refractive surgery of the cornea or crystalline lens and modification of the sclerociliary complex.

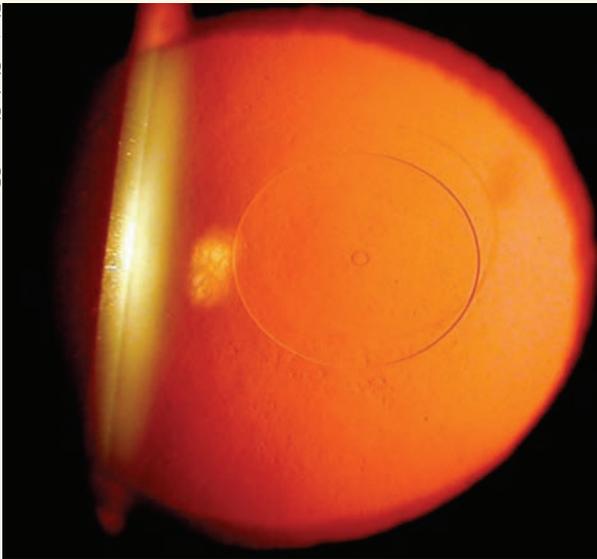


Fig 2. Flexivue Microlens within which a 0.5mm central perforation can be seen with retroillumination.

Another investigational accommodating IOL that changes curvature with accommodation is the FluidVision Lens (PowerVision), an acrylic implant filled with silicone oil. As the ciliary muscle contracts and relaxes, energy is transferred to the lens zonules and lens capsule. This energy squeezes fluid from the haptics into the optic, increasing its anterior curvature. The Dynacurve (NuLens) also uses a fluid reservoir that can be reshaped to adjust the accommodative power of the lens.

Also under development is the Sapphire AutoFocal Elenza (PixelOptics), which changes power when accommodation is sensed, using a process its developer calls “electroactive optics.” A microscopic battery in this electronic implant stimulates internal liquid crystals when pupil size decreases; however, unlike the FluidVision lens, the Elenza implant is independent of the ciliary muscle and capsular bag biomechanics.

Similar to presbyopia, the development of cataracts is also common in those who live long enough. As cataract extraction

with the insertion of a presbyopia-correcting IOL kills two birds with one stone, the ideal multifocal or accommodating IOL candidate is a patient requiring cataract surgery with no underlying ocular pathology. A refractive lens exchange is the removal of the natural lens without visually significant cataract, and although

it is performed for some higher refractive errors with and without a presbyopia correction IOL, it is typically avoided with low ametropias due to both the greater risk in comparison with laser vision correction and the greater intolerance to multifocality in emmetropic and low myopic patients.

REFRACTIVE SURGERY OF THE CORNEA OR LENS

Laser vision correction to induce monovision, in which one eye is focused for distance and the other for near, is commonly performed for patients in the presbyopic age range. Monovision can also be achieved with monofocal IOLs or contact lenses, and is overall the most popular surgical solution to presbyopia.

Advantages of monovision include spectacle freedom from most daily tasks, a high success rate and the possibility of reversal with enhancement or spectacles. However, stereopsis and contrast sensitivity can be reduced and success relies on neuroadaptation, which is a challenge in highly demanding

patients. Additionally, the patient may need glasses for low light conditions, such as night driving.

- **Corneal procedures** for presbyopia correction are newer and much less common than IOLs. These procedures include *presby-LASIK* (asphericity modification of the cornea under a flap with an excimer laser), *Intracor* (femtosecond laser creation of concentric, intrastromal cylindrical incisions) and the implantation of various *corneal inlays*, which include the following investigational devices: Intracor (Technolas Perfect Vision), Kamra Inlay (Acufocus), Raindrop Inlay (ReVision Optics), Flexivue Microlens (Presbia) and Icolens (Neoptics).² None of these procedures are currently FDA approved.

Presby-LASIK creates a multifocal cornea by inducing higher-order aberrations that increase depth of focus. Two primary approaches exist: *central presby-LASIK* and *peripheral presby-LASIK*.²

Central presby-LASIK creates a steeper myopic corneal center surrounded by a flat hyperopic periphery. This induces negative spherical aberration, which is the most promising aberration used to expand depth of focus. A pin-hole effect is created as the pupil constricts with convergence; the central myopic rays are focused through the small pupil, allowing the eye to focus at near. Literature also suggests a faster neuroadaptation response time to this type of aberration.¹¹

In contrast, peripheral presby-LASIK induces positive spherical aberration, which increases pseudo-accommodation. The flattened corneal center focuses distance, while the steepened periphery focuses near. For patient selection, the effects of these aberrations can be simulated using an adaptive op-

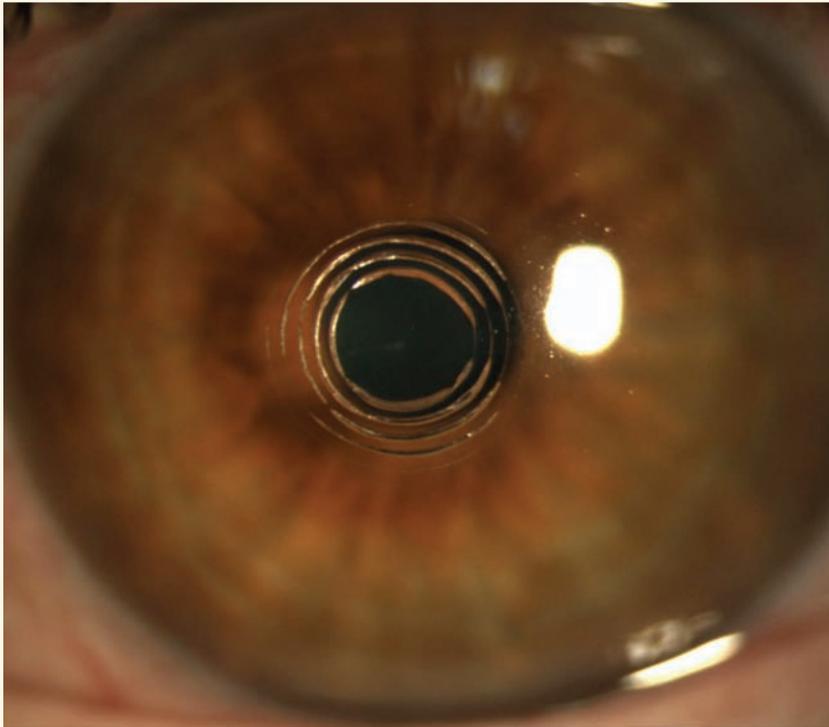


Fig 3. Above: A 3d model of the Intracor ablation profile. Below: Clinical appearance three hours post-Intracor treatment.

tics visual simulator (AOVS). This diagnostic device measures and corrects for pre-existing aberrations, while inducing new aberrations to expand depth of focus and preserve distance visual quality.¹² Clinical outcomes for both peripheral and central presby-LASIK show promise, but further studies are needed to investigate long-term stability of the procedure and quality of vision under low contrast settings.²

Intracor creates a hyperprolate, multifocal cornea with femtosecond laser intrastromal incisions in a concentric, cylindrical shaped pattern. Prior to surgery, the line of site is marked using the first Purkinje image. During surgery, five concentric intrastromal rings are cut 2.0mm to 4.0mm from the line of sight.¹³ These intrastromal circular incisions change the local corneal biomechanics and conse-

quently reshape the cornea. The corneal epithelium and Bowman's layer remain undamaged during Intracor implantation, allowing the incisions to heal fast.

Although our understanding of the cornea's biomechanics has grown with advancements in corneal crosslinking, the risk of corneal ectasia still exists after incisional corneal manipulation. In one case report, ectasia developed with an anterior corneal protrusion after hyperopic LASIK followed by Intracor.¹⁴ However, another study shows stable corneal steepening and pachymetry at 12 months after Intracor.¹⁵

Corneal inlays are currently used in Canada and will likely gain FDA approval soon. The closest to approval is the Kamra, which measures 3.8mm in diameter and 5 μ m thick with a central 1.6mm aperture. This inlay is implanted

in a femtosecond laser-enabled pocket at a depth of 200 μ m in the nondominant eye, where it reduces the normal aperture for light entry into the eye, thereby creating a pinhole effect and increasing depth of focus.

The Kamra contains laser-etched microscopic openings that maintain metabolic flow to the anterior cornea. These openings are placed in a random pattern to prevent diffraction issues at night. The inlay does not affect examination, and imaging of internal ocular structures and visual field testing shows unchanged thresholds pre- and post-implantation.

Outside of the US, a combined LASIK and Kamra implantation procedure is gaining popularity for the simultaneous treatment of ametropia and presbyopia. In this procedure, the inlay is either placed under a 200 μ m LASIK flap after excimer ablation or implanted in a pocket deep to a more anterior LASIK flap.²

Two other corneal inlays, the Raindrop and Flexivue, work by central, anterior corneal curvature change and central change in refractive index, respectively. Though rarely used today, conductive keratoplasty is yet another option to induce corneal shape change.

• **Lenticular alteration.** Experimental presbyopic refractive surgery of the lens is also underway. Intra-lenticular ablation using femtosecond laser, or phacophotomodulation, aims to "soften" the crystalline lens to restore accommodation. In theory, laser micro-perforations within the hard lens nucleus enhance lens fiber sliding, increasing lens flexure and facilitating accommodation.

In a 2001 study, phacophotomodulation in cadaver eyes reversed age-related loss of lens

elasticity.¹⁷ Interestingly, other research suggests that femtosecond laser-generated nuclear pinpoint opacities do not cause cataract progression. The same group also created a computer model of the crystalline lens to explore the efficacy of various photodisruption patterns on lens fiber motility.¹⁸

SCLEROCILIARY INTERVENTION

The modification of the sclerociliary complex with scleral implants, a blade or laser is also being investigated as an approach to increase accommodation. Although the mechanism is not fully understood and remains controversial, some believe that increased zonular tension causes accommodation.

Scleral implants, such as the PresViews scleral implant (Refocus Group)—a two-piece clear plastic device approximately the size of a grain of rice—increase tension between the lens equator and ciliary muscle, therefore driving accommodation.¹⁹ This invasive technique comes with serious risks, however, including migration or extrusion of the implant, scleral perforation, retinal detachment, choroidal or retinal hemorrhage and endophthalmitis. On a more encouraging note, the procedure is extraocular, the visual axis remains untouched during surgery and the implants are removable, meaning the effects may be reversible.

Another developing technology is the LaserAce system (Ace Vision Group), which uses an erbium-YAG laser to create numerous ablation spots through 90% of the scleral depth in an attempt to ease contraction of the ciliary muscle.²⁰

SUMMARY

Just as benefits and setbacks exist with nonsurgical presbyopia cor-

rection, surgical techniques—while effective—are far from perfect.

Current successful techniques include multifocal and accommodating IOLs, as well as monovision induced by monofocal IOLs or corneal refractive surgery. Several upcoming procedures like corneal inlays and presby-LASIK also show promise and will likely gain FDA approval in the near future.

Other surgeries—including scleral implants, phacomodulation and corneal reshaping through intrastromal femtosecond laser ablation—remain investigational and likely require significant advancements before commercialization can be expected.

Regardless, while these techniques each offer varying degrees of success, the ophthalmic and optometric community has yet to develop a sure-fire solution to presbyopia that does not compromise vision or quality of life. A procedure or product that restores accommodation without compromise or risk of adverse effects is in high demand but thus far remains undiscovered. **RCCL**

1. Ahmad BU, Shah GK, Hardten DR. Presbyopia-correcting intraocular lenses and corneal refractive procedures: a review for retinal surgeons. *Retina*. 2014;34:1046-1054.

2. Waring GO, Berry DE. Advances in the surgical correction of presbyopia. *International Ophthalmology Clinics*. 2013;53:129-152.

3. Gooi P, Ahmed IK. Review of presbyopic IOLs: multifocal and accommodating IOLs. *International Ophthalmology Clinics* 2012;52:41-50.

4. Davison JA, Simpson MJ. History and development of the apodized diffractive intraocular lens. *Journal of Cataract and Refractive Surgery*. 2006;32:849-858.

5. Maxwell WA, Lane SS, Zhou F. Performance of presbyopia-correcting intraocular lenses in distance optical bench tests. *Journal of Cataract and Refractive Surgery*. 2009;35:166-171.

6. Comander J, Pineda R. Accommodating intraocular lenses: theory and practice. *International ophthalmology clinics*. 2010;50:107-117.

7. Yuen L, Trattler W, Boxer-Wachler BS. Two cases of Z syndrome with the Crystalens

after uneventful cataract surgery. *Journal of Cataract and Refractive Surgery*. 2008;34:1986-1989.

8. McLeod SD, Vargas LG, Portney V, Ting A. Synchrony dual-optic accommodating intraocular lens. Part 1: optical and biomechanical principles and design considerations. *Journal of Cataract and Refractive Surgery*. 2007;33:37-46.

9. Ossma IL, Galvis A, Vargas LG, Trager MJ, Vagefi MR, McLeod SD. Synchrony dual-optic accommodating intraocular lens. Part 2: pilot clinical evaluation. *Journal of Cataract and Refractive Surgery*. 2007;33:47-52.

10. Bohorquez V, Alarcon R. Long-term reading performance in patients with bilateral dual-optic accommodating intraocular lenses. *Journal of Cataract and Refractive Surgery*. 2010;36:1880-1886.

11. Alio JL, Amparo F, Ortiz D, Moreno L. Corneal multifocality with excimer laser for presbyopia correction. *Current Opinion in Ophthalmology*. 2009;20:264-271.

12. Rocha KM, Vabre L, Chateau N, Krueger RR. Expanding depth of focus by modifying higher-order aberrations induced by an adaptive optics visual simulator. *Journal of Cataract and Refractive Surgery*. 2009;35:1885-1892.

13. Holzer MP, Mannsfeld A, Ehmer A, Auffarth GU. Early outcomes of INTRACOR femtosecond laser treatment for presbyopia. *Journal of Refractive Surgery*. 2009;25:855-861.

14. Saad A, Grise-Dulac A, Gatinel D. Bilateral loss in the quality of vision associated with anterior corneal protrusion after hyperopic LASIK followed by intrastromal femtosecond laser-assisted incisions. *Journal of Cataract and Refractive Surgery*. 2010;36:1994-1998.

15. Menassa N, Fitting A, Auffarth GU, Holzer MP. Visual outcomes and corneal changes after intrastromal femtosecond laser correction of presbyopia. *Journal of Cataract and Refractive Surgery*. 2012;38:765-773.

16. Myers RI, Krueger RR. Novel approaches to correction of presbyopia with laser modification of the crystalline lens. *Journal of Refractive Surgery*. 1998;14:136-139.

17. Krueger RR, Sun XK, Stroh J, Myers R. Experimental increase in accommodative potential after neodymium: yttrium-aluminum-garnet laser photodisruption of paired cadaver lenses. *Ophthalmology* 2001;108:2122-2129.

18. Krueger RR, Kuszak J, Lubatschowski H, Myers RI, Ripken T, Heisterkamp A. First safety study of femtosecond laser photodisruption in animal lenses: tissue morphology and cataractogenesis. *Journal of Cataract and Refractive Surgery*. 2005;31:2386-2394.

19. Schachar RA. Theoretical basis for the scleral expansion band procedure for surgical reversal of presbyopia [SRP]. *Comprehensive Therapy* 2001;27:39-46.

20. Swartz TS, Rocha KM, Jackson M, Ma DH, Goldberg D, Hipsley A. Restoration of accommodation: new perspectives. *Arquivos Brasileiros de Oftalmologia*. 2014;77:V-VII.

21. <http://www.abottmedicaloptics.com/products/cataract/refractive-iols/rezoom-multifocal-iol>.



SURGICAL CORRECTION OF PRESBYOPIA

CE TEST - NOVEMBER 2014

- Which of the following is not a presbyopic IOL solution?
 - Refractive multifocal lens
 - Accommodating IOL
 - Diffraction multifocal lens
 - Implantable collamer lens (ICL)
- Which of the following patient characteristics are supportive of the use of a presbyopic IOL?
 - Corneal astigmatism of 2.00D
 - Willingness to tolerate some visual imperfections to the overall goal of reducing spectacle dependence
 - Presence of an epiretinal membrane
 - High visual demands across a broad range of focal points
- Which is NOT true of multifocal IOLs?
 - Diffraction IOLs have widely replaced refractive IOLs
 - The different diffraction/refractive zones are set to either distance or near vision. Intermediate vision is dependent on asphericity of the lens
 - Distance vision with refractive IOLs is compromised by bright light, given the arrangement of the refractive powers
 - Despite diffraction ridges, which are very prominent on slit lamp exam, diffraction IOLs are thought to actually generate more glare than refractive IOLs, which have more subtle transition zones.
- What does the term "apodized" refer to?
 - Circumferential arrangement of gradually increasing refractive power.
 - A diffraction lens in which the diffraction ridges gradually increase in size from lens center to the periphery.
 - Diffraction lenses that use apodized ridges may improve distance vision in low light, as lower profile ridges in the periphery of the lens direct more light to the distance focal point
 - Diffraction lenses that use apodized ridges may improve near vision in low light as higher profile ridges in the periphery of the lens direct more light to the near focal point
- Which is NOT true of accommodating or pseudoaccommodating IOLs compared to multifocal IOLs?
 - They generally create less scotopic phenomenon than multifocal IOLs
 - They have less impact on contrast sensitivity than multifocal IOLs
 - Their accommodative performance may be impacted by both presence of fibrosis of the posterior capsule or absence of a posterior capsule, as in eyes that have received a YAG capsulotomy
 - Dual-optic designs improve accommodative effect and can be placed through a similarly sized incision as single optic designs
- Which is NOT true of dual-optic IOLs?
 - They offer greater accommodative effect than single optic designs
 - YAG capsulotomy may be expected to significantly limit their effectiveness
 - A larger incision complicates the surgery and changes post-operative risks
 - Only one of these lenses is currently FDA approved
- Which is true regarding LASIK-based attempts to treat presbyopia?
 - Presby-LASIK can be used to induce either positive or negative spherical aberration to increase depth of focus
 - The effects of presby-LASIK are unable to be demonstrated to a patient prior to surgery
 - Peripheral presby-LASIK is dependent on accommodative miosis
 - Central Presby-LASIK is FDA approved while peripheral is not
- Which corneal treatment of presbyopia involves creation of concentric corneal rings?
 - Intracor
 - Presby-LASIK
 - Kamra inlay
 - Raindrop inlay
- What is the mechanism by which the Kamra corneal inlay treats the effects of presbyopia?
 - Refractive multifocality
 - Diffraction multifocality
 - Positive Spherical aberration
 - Pinhole effect
- Which of these is FDA approved for the management of presbyopia?
 - Kamra Inlay
 - Synchony IOL
 - Presby-LASIK
 - None of these are currently approved

EXAMINATION ANSWER SHEET

The Final Cut: Surgical Correction of Presbyopia

Valid for credit through November 1, 2017

Online: This exam can also be taken online at www.reviewofcontactlenses.com. Upon passing the exam, you can view your results immediately. 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.

Mail to: Jobson Optometric CE, Canal Street Station, PO Box 488 New York, NY 10013

Payment: Remit \$20 with this exam. Make check payable to Jobson Medical Information LLC.

Credit: COPE approval for 1 hour of CE credit is pending for this course.

Sponsorship: Joint-sponsored by the Pennsylvania College of Optometry

Processing: There is an eight-to-10 week processing time for this exam.

Answers to CE exam:

- | | |
|--------------------|---------------------|
| 1. (A) (B) (C) (D) | 6. (A) (B) (C) (D) |
| 2. (A) (B) (C) (D) | 7. (A) (B) (C) (D) |
| 3. (A) (B) (C) (D) | 8. (A) (B) (C) (D) |
| 4. (A) (B) (C) (D) | 9. (A) (B) (C) (D) |
| 5. (A) (B) (C) (D) | 10. (A) (B) (C) (D) |

Evaluation questions (1 = Excellent, 2 = Very Good, 3 = Good, 4 = Fair, 5 = Poor)

Rate the effectiveness of how well the activity:

- Met the goal statement: ① ② ③ ④ ⑤
- Related to your practice needs: ① ② ③ ④ ⑤
- Will help improve patient care: ① ② ③ ④ ⑤
- Avoided commercial bias/influence: ① ② ③ ④ ⑤
- How do you rate the overall quality of the material? ① ② ③ ④ ⑤
- Your knowledge of the subject increased: Greatly Somewhat Little
- The difficulty of the course was: Complex Appropriate Basic
- How long did it take to complete this course? _____
- Comments on this course: _____
- Suggested topics for future CE articles: _____

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References: 1. A market research study conducted amongst 107 US contact lens wearers representative of CLEAR CARE® purchasers in the United States, 2007. 2. Based on third party industry report 52 weeks ending 12/29/12; Alcon data on file. 3. Alcon data on file, 2009. 4. SOFTWEAR™ Saline package insert. 5. Paugh, Jerry R, et al. Ocular response to hydrogen peroxide. *American Journal of Optometry & Physiological Optics*: 1988; 65:2,91-98.

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CASE REPORT:

Resolving Central Islands Caused by Overnight Corneal Reshaping

Could a common procedure used to fix topographical central islands in fact worsen them in some cases?

By Brian Chou, OD, and Kimberly Michel, OD

Most eye care practitioners are familiar with topographical central islands caused by excimer laser refractive surgery. Observed mostly in the 1990s, this complication of PRK and LASIK is caused by the plume of evaporated stromal tissue impeding central ablation by a broadband excimer laser. The resulting corneal irregularity reduces best spectacle-corrected visual acuity. The advance of multi-zone, multi-pass excimer ablation, however, has led to a reduction of these so-called central islands.

Perhaps less recognized, overnight corneal reshaping using contact lenses (i.e., orthokeratology) can sometimes create central islands. Characteristics of patients predisposed to develop central islands in this manner are unknown. Discontinuing corneal reshaping would resolve them, but also contradict the patient's desire to undergo corneal reshaping. Hence, it is preferable to continue with corneal reshaping while looking for other means to handle central island development.

Central islands in corneal reshaping are generally accepted to result from excessive sagittal depth.¹⁻⁴ With the particular implementation of ortho-K known as corneal refractive therapy (CRT, Paragon Vision Sciences), sagittal depth is most easily decreased by reduc-

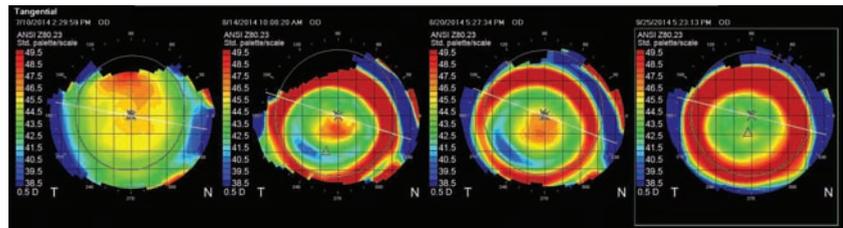


Fig. 1. Right eye trend analysis of tangential topographies. From left to right: (a) pre-treatment; (b) one week after initiating CRT showing central island; (c) six days after CRT with RZD decreased by 25µm; and (d) three weeks after CRT with RZD increased by 25µm from the original lens.

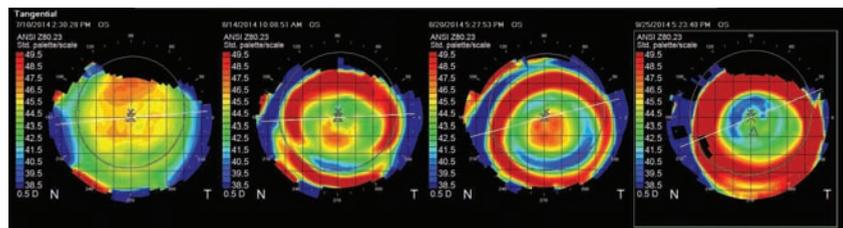


Fig. 2. Left eye trend analysis of tangential topographies. From left to right: (a) pre-treatment; (b) one week after initiating CRT showing central island; (c) six days after CRT with RZD decreased by 25µm; and (d) three weeks after CRT with RZD increased by 50µm from the original lens.

ing return zone depth (RZD). It is usually recommended that practitioners reduce RZD by 25µm while maintaining all other parameters (base curve and landing zone angle or LZA).¹ Reducing RZD, however, can cause lens instability, induced astigmatism and myopic regression, and also does not guarantee elimination of central islands. In fact, this case demonstrates how reducing RZD worsened central islands and how their resolution actually required increasing RZD.

CASE REPORT

An 11-year-old Asian female underwent corneal refractive therapy. Her pre-CRT ocular health status

was unremarkable and non-contributory at all visits. UCVA was OD 20/200, OS 20/200. Manifest refraction was OD -3.50-0.50X075 (20/20+) and OS -3.75-0.50X125 (20/20+). Topographies were prolate and unremarkable (*Figures 1a and 2a*). CRT lenses were dispensed OU according to the Paragon's

ABOUT THE AUTHORS



Drs. Chou and Michel practice at EyeLux Optometry, one of the largest contact lens practices in San Diego.

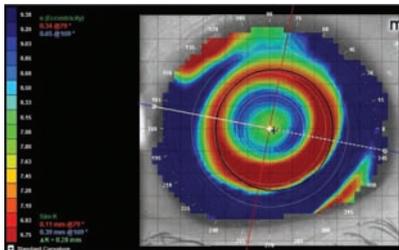


Fig. 3. A well-centered treatment zone with a central island indicates a sag reduction (LZA decrease) to “squash” the raised central area.

CRT lens selection nomogram, with 8.2 BC / 550 RZD / 34 LZA in each eye. One week later, UCVA had improved to OD 20/80 and OS 20/40, with manifest refraction OD pl-1.75X070 (20/40) and OS -0.75-1.00X090 (20/25+). Topography showed central islands OU (*Figures 1b and 2b*).

Per the manufacturer’s guidelines, RZD was decreased by 25µm OU and she began wearing 8.3 BC / 525 RZD / 34 LZA, which still provided reasonable centration and lens stability. Six days later, UCVA was OD 20/80 OD and OS, with manifest refraction OD -3.50-0.75X050 (20/25) and OS -6.00DS (20/25). On topography, the central islands were more pronounced in each eye (*Figures 1c and 2c*).

New CRT lenses were dispensed with OD 8.3 BC / 575 RZD / 34 LZA and OS 8.4 BC / 600 RZD / 34 LZA. Three weeks later, UCVA was OD 20/20- and OS 20/30, with manifest refraction OD -0.50-0.50X075 (20/15-) and OS -0.75-0.50X130 (20/25). Topography showed the central islands resolved in the right eye almost completely and in the left eye partially (*Figures 1d and 2d*).

OPPOSITES ATTRACT

This case illustrates how the typical procedure of decreasing RZD for central islands can sometimes make them more pronounced. For this patient, increasing sagittal depth

resolved the central island in the right eye and partially resolved it in the left eye.

Kopp et al. observed that decreasing LZA by one degree leads to enough of a sagittal depth decrease (approximately 15µm) to allow the entire lens to settle closer to the corneal surface and “squash” most central islands. The LZA change does not significantly affect lens centration. The group also found that decreasing sagittal depth by decreasing RZD did not eliminate central islands. Instead, increasing sagittal depth via an RZD increase typically eliminated the central island, as it did in this case report.

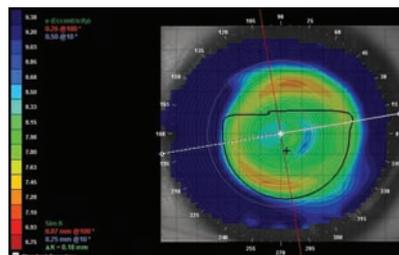


Fig. 4. Decentered treatment zone with a central island indicates a deeper sag (RZD) is needed to create the necessary pressure in all meridians to show the completed circle of raised epithelium.

According to Kopp, the post-treatment tangential topographic map should guide the strategy for resolving central islands. Usually, if the tangential map shows a well-centered treatment zone with a full circle of mid-peripheral steepening but with a central island (*Figure 3*), decreasing LZA effectively eliminates the central island.

However, as Kopp found, if the tangential map shows an incomplete ring of mid-peripheral steepening in addition to a central island (*Figure 4*), increasing the RZD by 25µm could resolve the central island. You can see in this topography there is not enough reshaping in the horizontal merid-

ian to match the mid-peripheral steepening in the vertical meridian. Increasing the RZD 25µm allows more pressure in the periphery (in all meridians at an 8mm chord) to fill in the epithelial ring and complete the “closed system” necessary for an appropriate tear volume for complete myopic treatment. In this example, the central island would be minimized with a new lens with increased sagittal depth. Oval (vs. round) treatment zones also suggest inadequate sagittal depth and a need for the practitioner to increase RZD.

In summary, this case suggests central islands may be treated by decreasing LZA by one degree while keeping other parameters the same. Alternatively, when peripheral steepening does not form a complete circle on tangential topography, RZD may be increased by 25µm while keeping other parameters the same.

It is important to note this case may not reflect recommendations for central islands induced from wearing ortho-K lens designs that differ from the CRT approach. Also, more research with a larger patient sample size is welcome. [RCC](#)

The authors wish to thank Ken Kopp, FCLSA, at Paragon Vision Sciences for his assistance with this report.

1. Paragon Vision Sciences. Professional Fitting and Information Guide for Paragon CRT or Paragon CRT 100. Available at: <https://aroptical.com/files/documents/resources/ParagonCRT-FittingGuide04-04.pdf>. Accessed October 17, 2014.
2. Jackson J. Central Island Topography Patterns and Increase in Myopia with Overnight Corneal Refractive Therapy. Poster presented at the Annual American Academy of Optometry Meeting, 2002.
3. Taub, MB. Corneal refractive therapy (CRT): An alternative method of vision correction. *Optometry Today*, Available at www.optometry.co.uk/uploads/articles/b09d18b658e5003ce-67fe8084adfleae_taub20030516.pdf. Accessed October 17, 2014.
4. McCampbell K, Bennett ES, Rah MJ. Corneal Reshaping Made Easy. *Contact Lens Spectrum*. October 2014. Available at www.clspectrum.com/articleviewer.aspx?articleID=12676



Secrets of the Serum

Ongoing research reveals how to better manage dry eye with autologous serum eye drops.

Generally reserved for more severe, recalcitrant dry eye syndrome (DES), autologous serum (AS) can play an important role in treatment for certain patients. According to the International Dry Eye Workshop, AS is most suitable for severity level 3 dry eye patients with TBUT ≤ 5 seconds, Schirmer tear test ≤ 5 mm in five minutes, moderate to marked staining, and severe symptoms that do not respond to simpler treatments.^{1,2}

Though AS eye drops have been used to manage dry eye for more than 30 years, researchers are still looking for the “best” concentration. In the last 18 months, several new studies evaluating AS in the management of DES and other corneal diseases have been published.³ Their findings are summarized below with emphasis on the clinical significance of their conclusions.

A SERUM SIX-PACK

The following six studies help us to understand the clinical viability of AS as a treatment modality, particularly in severe DES.

- **AS beats AT.** Celebi et al. evaluated 20% AS (saline diluent) compared to preservative-free (PF) artificial tears (AT) in patients with severe DES who had failed to respond to conventional dry eye therapies. Following a two-week washout period using PF isotonic saline, subjects were randomized to either AS or artificial tears dosed every six hours. After one month of therapy and a second two-week washout period, the treatments were switched.

Compared to baseline, both therapies resulted in slightly increased Schirmer and slightly less ocular surface staining. Symptoms also improved in both groups, but statistically and clinically significantly more so when subjects were treated with AS. TBUT increased from two seconds at baseline to four seconds following one month of therapy with AS, but only to three seconds with PF AT. Overall, AS was more effective in improving comfort and stabilizing the tear film. In this study, 100% of patients had relief of severe dry eye symptoms.³

- **Healing response seen.** In a study by Jirsova et al., a small group of patients (n=17) with severe DES instilled 20% AS (saline diluent) drops 15 minutes after artificial tear use up to 12 times a day for three months. Patient symptoms improved and remained better than baseline three months after cessation of AS treatment. There was also improvement in ocular surface dryness (via Schirmer) and goblet cell density of the bulbar conjunctiva. Epithelial cell density increased significantly, signaling a reduction in the degree of squamous metaplasia. The authors concluded that a three-month treatment with AS led to an improvement in ocular surface dryness and epithelium health.⁷

- **Good for corneal pathology.** A single-site prospective study evaluated AS in patients with corneal pathologies such as recurrent corneal erosion, neurotrophic keratopathy, KCS and corneal burns. Patient signs and symptoms improved irrespective of corneal pathology.⁴

- **Thwarted by cytokines.** Hwang et al. studied AS in DES patients

with primary and secondary Sjögren’s syndrome (SS). Characterized by chronic inflammation affecting salivary and lacrimal glands, SS is classified as secondary when associated with diseases such as rheumatoid arthritis or systemic lupus erythematosus and has been linked to an increased level of serum proinflammatory cytokine levels—a connection some believe may inhibit the abilities of AS.

This group reported proinflammatory cytokine levels to be higher in patients with secondary SS vs. primary after evaluating patients before and after four weeks of AS (50%; diluted with 0.1% sodium hyaluronate) used eight times a day. The authors concluded that AS might not be helpful with managing severe DES in secondary SS due to the elevated serum level of detrimental cytokines.⁸

- **SH allows sustained release.** Another study of SS patients (n=26) compared AS 20% diluted in either saline or sodium hyaluronate (SH)—one in each eye—over two months. Drops were instilled every eight hours and vials were discarded every seven days. López-García et al. reported AS with SH exhibited excellent stability for one month in both fresh and defrosted samples, as well as improvement over AS with saline in tear film stability, staining, TBUT and patient symptoms. The study concluded SH allows for a sustained release of various growth factors, thereby making it an excellent diluent for AS.⁹

- **Alternative to AS?** Watson et al. evaluated therapeutic ocular surface medium (TOSM), a preservative- and antibiotic-free serum substitute

manufactured to allow culturing of epithelial cells in a lab setting, for persistent epithelial defects (PED). Containing similar components, TOSM is more available and easier to prepare than AS, making it a possible alternative for various corneal pathologies. In this study, the majority of patients showed PED improvement and tolerance of TOSM. The authors concluded that TOSM might be a potential therapy for PED without some of the supply concerns noted with AS.¹⁰

THE TAKE-HOME MESSAGE

With respect to these studies, AS at concentrations of 20% to 50% diluted in SH appears to be the most effective formulation and so should be considered in advanced DES unresponsive to more traditional therapies. No more than 50% of AS should be considered due to the risk of pathogen incubation. Additionally, if SS patients present with an underlying systemic connective tissue disease, caution should be used in determining treatment. Lastly, TOSM might have the nutrient benefits of AS without the difficulty of production, but more research is needed to confirm. **RCCL**

1. Management and therapy of dry eye disease: report of the management and therapy subcommittee of the international dry eye workshop (2007). *Ocul Surf.* 2007;5(2):163-178.

2. The definition and classification of dry eye disease: report of the definition and classification subcommittee of the international dry eye workshop (2007). *Ocul Surf.* 2007;5(2):75-92.

3. Celebi ARC, Ulusoy C, Mirza GE. The efficacy of autologous serum eye drops for severe dry eye syndrome: a randomized double-blind crossover study. *Graefes Arch Clin Exp Ophthalmol.* 2014;252:619-626.

4. Semeraro F, Forbice E, Braga O, et al. Evaluation of the efficacy of 50% autologous serum eye drops in different ocular surface pathologies. *Biomed Res Int.* 2014; Published online Jul 22.

How Does it Work?

Certain components in AS—epidermal growth factor, nerve growth factor, insulin-like growth factor 1, neurotrophic factors (substance P), bacteriostatic factors (lysozyme, immunoglobulins), fibronectin and vitamin A—may preserve and even restore ocular surface integrity by exerting epitheliotropic effects. This composition makes AS suitable to treat dry eye, neurotrophic keratitis, persistent corneal epithelial defects, recurrent corneal erosions, superior limbic keratoconjunctivitis, acute corneal burns and post-op dry eye after refractive surgery.^{4, 5}

AS eye drops are compounded using whole venous blood obtained from the patient via venipuncture, which is left to stand at room temperature for two hours to allow for clotting to occur. The serum is then separated from the clot by centrifugation for 10 minutes at 4,000 RPM (or at a speed not so high as to cause hemolysis). In a laminar flow cabinet under sterile environment, the supernatant liquid is drawn off and diluted (typically using isotonic (0.9%) preservative-free saline) to the desired concentration. The resulting eye drops are placed in opaque containers to prevent UV degradation of vitamin A.

In the US, the FDA and the American Association of Blood Banks typically require autologous blood donors to have a minimum hemoglobin concentration of 11 g/dL (33% hematocrit) and be free of conditions that may result in bacteremia. Patients should also be well enough to undergo venipuncture several times a year and be able to tolerate blood loss. Because other family members may unintentionally use these serum drops, it is recommended that the donor be tested for blood-transmitted diseases such as HIV and hepatitis C.⁵

AS eye drops diluted in saline are typically instilled four to eight times daily.⁵ AS vials should be refrigerated between use and discarded on a regular basis at least every month (though some prefer to have patients replace vials weekly). Extra AS drops can be kept in the freezer for up to three months. There is no need for the drops to contain an antibiotic, due to the bacteriostatic nature of serum imparted by immunoglobulins and lysozyme. Also, as the inclusion of a preservative has the potential for additional corneal toxicity, AS eye drops are typically preservative free.⁶

AS eye drops are generally well tolerated by patients, but rare complications do exist, including deposition of immune complexes in the cornea and peripheral corneal infiltrates.³ Higher concentrations of AS eye drops also require more blood, raising the risk of anemia.

5. Pan Q, Angelina A, Zambrano A, et al. Autologous serum eye drops for dry eye. *Cochrane Database Syst Rev.* 2013. Published online Aug 23.

6. Cho YK, Huang W, Kim GY, Lim BS. Comparison of autologous serum eye drops with different diluents. *Current Eye Research.* 2013;38(1):9-17.

7. Jirsova K, Brejchova K, Krabcova I, et al. The application of autologous serum eye drop in severe dry eye patients; subjective and objective parameters before and after treatment. *Current Eye Research.* 2014;39(1):21-30.

8. Hwang J, Chung SH, Jeon S, et al. Comparison

of clinical efficacies of autologous serum eye drops in patients with primary and secondary sjogren syndrome. *Cornea.* 2014;33(7):663-667.

9. López-García JS, García-Lozano I, Rivas L, et al. Autologous serum eye drops diluted with sodium hyaluronate; clinical and experimental comparative study. *Acta Ophthalmol.* 2014;92(1):e22-29.

10. Watson SL, Geerling G, Dart JKG. Clinical therapy of therapeutic ocular surface medium for persistent epithelial defect. *Ophthalmic Res.* 2014;51(2):82-87.



When Surgery Falls Short

Patients who experience vision deterioration following refractive surgery often do not realize contacts may be an option. There are many!

Refractive surgery can leave patients happy for many years. Unfortunately, in some cases, their refraction starts to degrade and they appear at your door, disappointed with their newfound blurry vision. What course of action would best suit these patients? Enhancement surgery? Glasses? Soft lenses? Custom lenses? Gas permeables?

A LENS FOR EVERY EYE

When patients undergo refractive surgery, their corneal shape is permanently altered. In some cases, patients can achieve post-op functional vision with standard glasses or soft contacts, and this option should be discussed. However, GP lens designs are often the only option to return their vision to 20/20.

- **Glasses.** Patients are sometimes able to see fairly well (20/40 or better) or even extremely well (20/20) with a spherocylindrical refraction. If this is the case, glasses should be presented as an option. However, 20/20 quantity with glasses does not always translate to 20/20 quality, so I always offer contact lenses first if the patient is a good candidate.

For example, I had a patient who had undergone previous RK surgery and who had worn progressive addition lenses for many years. With glasses, his vision was 20/20 in each eye. Although he had good vision, I asked him if he was interested in contact lenses. He was shocked; all these years, he thought contacts were not an option for him. “I would love to get back into contacts if I could!” he said.

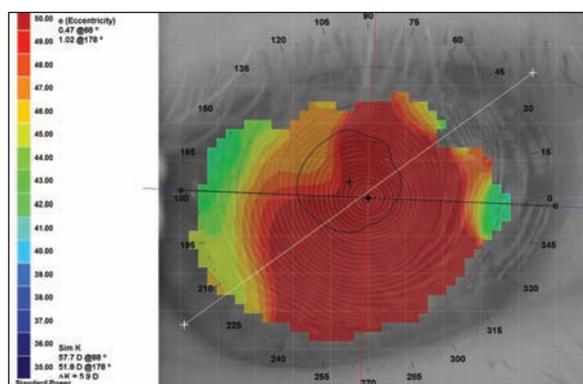


Fig 1. Post-LASIK ectasia shows steepening centrally, similar to a keratoconus patient.

- **Soft contact lenses.** A patient with a fairly normal prescription and minimal irregular astigmatism may be a good candidate for soft contact lenses. I find most have undergone LASIK or PRK, rather than RK surgery.

If you have trial lenses on hand, try applying a pair to the patient's eyes to check vision clarity and lens fit. If the contacts fit well and the vision is acceptable, the patient could save a bit of money by using a basic lens. A standard soft toric lens may also work if the patient is able to achieve acceptable vision with refraction with some astigmatism. It's best to start with the easiest and most cost-effective solution for the patient when possible.

- **Soft custom toric lenses.** Able to be made with virtually any base curve and power, custom soft lenses are perfect for patients with fairly regular astigmatism too high for standard soft toric lenses. Also, some soft custom lenses like Novacone, Kerasoft IC and Flexlens ARC have an increased center thickness to help mask small to moderate

amounts of irregular astigmatism. Soft custom lenses are usually available in one-degree axis increments, which can really dial in a patient's vision.

- **Hybrid lenses.** These combination lenses may be the answer for patients with a fairly normal corneal shape. Hybrid contact

lenses combine a GP center with a soft lens skirt to give the patient the vision clarity of a GP lens and the comfort of a soft lens. The GP portion of the lens could help to correct any irregular astigmatism as well. However, I wouldn't recommend a hybrid lens on a severely irregular cornea—the lens will likely decenter and corneal staining can often be seen. There is also a risk of corneal flattening over time.

Often, the GP portion will land at the “knee” of the treatment zone, causing seal-off or an abrasion. As an aside, RK patients have a more profound knee because, since tissue is not removed, as the center is flattened, the periphery is steepened.

- **Corneal and intralimbal GP lenses.** Certain corneal and intralimbal GP designs can be beneficial for patients who have undergone previous refractive surgery. These designs contain unique reverse curves with varied amounts of curvature to match the oblate shape of a previously myopic eye. It's best to discuss design recommendations with a

laboratory consultant, however, as all GP labs have surgery-specific designs.

- **Scleral lenses.** Sclerals are another option for many post-refractive surgical patients. These large lenses vault the cornea and rest on the sclera with a layer of liquid cushioned underneath, a design that can have many benefits.

First, since the lens does not touch the cornea, keratitis and

has an extremely irregular cornea or sclera, consider the EyePrintPro system, which takes an impression of the patient's unique ocular surface, generates a three-dimensional scan, then uses software to create a lens perfectly shaped to the entire ocular surface. The extreme stability of this design allows both toric and prism correction to be placed in any axis. Though any refractive surgery patient could be considered

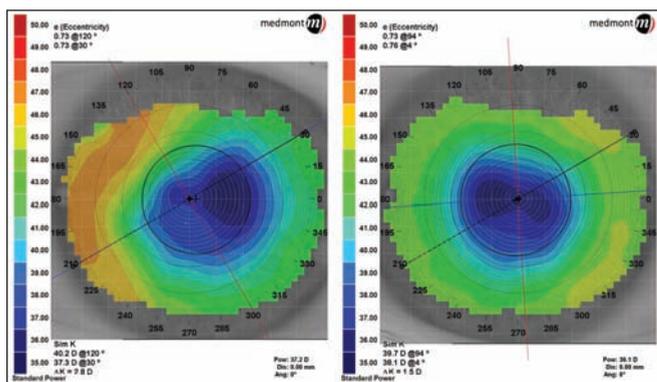


Fig 2. Post-RK patient showing oblate corneas.

scarring risks are greatly decreased. Second, the fluid layer helps to prevent fluctuating vision in post-RK patients, who are notorious for having varied refractions throughout the day. This is often thought to be due to the ever-changing corneal shape from hour-to-hour, and offering these patients a solution to their constantly fluctuating vision can be invaluable. Third, many patients who have undergone refractive surgery complain of dry eye. As scleral lenses are often used to treat dry eye symptoms, they can offer a solution to your patient's vision inconsistencies and discomfort.

- **EyePrint Lenses.** If a patient

a candidate for this lens, RK patients in particular would greatly benefit from this device.

It's important to note that both post-LASIK ectasia and hexagonal keratectomy

patients exhibit topographies similar to a keratoconic patient (Figure 1). Fitting them is very similar to fitting a keratoconic or pellucid marginal degeneration patient, so fit these patients with your favorite keratoconic design!

CASE REPORT

A 58-year-old Caucasian female presented to the clinic for a comprehensive eye exam. She reported undergoing RK in both eyes in 1992 and has worn lined bifocal glasses for the past 15 years. She complained of dry eyes and blurred and fluctuating vision.

Her BCVA in the OD was 20/70

and the OS was 20/50 with a large amount of irregular astigmatism in both eyes (Figure 2). Many RK scars were seen in both eyes under slit lamp examination.

At this time, scleral contact lenses were recommended. The patient was eager to try and solve some of her ocular complaints. After a diagnostic scleral contact lens fitting, the patient was dispensed:

OD: Atlantis scleral/ 7.85 BC/ 16.5 OAD/ standard limbal zone/ standard edge/ -3.50

OS: Atlantis scleral/ 7.78 BC/ 16.5 OAD/ increased limbal zone/ standard edge/ -4.00

Through these lenses, the patient saw 20/25 in both eyes.

During her follow-up visits, the patient reported less fluctuating vision while wearing her contacts and also decreased dry eye symptoms. She is extremely happy with the vision and comfort of the contacts, and I am happy with her corneal health. She has been successfully wearing these lenses for one year.

Generally, patients who have had refractive surgery are some of the best candidates for contact lenses because they likely underwent the surgery in the first place to eliminate the need for glasses. However, often they have been told by other doctors that they cannot wear contact lenses, so they may not even ask you about lens options.

So, the next time you have a post-surgical patient who normally wears glasses, offer them the option of contact lenses instead. You will be surprised at how many patients jump at the opportunity to enjoy contacts again! **RCCL**



Sharing is Caring: Delegate Your Contact Lens Fits

Here's why learning to let go is one secret to a successful practice.

Looking for a fun way to start your next local society meeting and incite a heated discussion at the same time? Stand up and proclaim, “I delegate refractions. Anyone have a problem with that?” Once the anticipated barroom brawl subsides, follow it up with, “Oh, and I also delegate contact lens fitting.”

In this profession, any discussion that involves taking the phoropter out of the doctors' hands immediately becomes personal. This is likely because refraction has become synonymous with the core services we provide. Similarly, as contact lens practitioners, the process of fitting lenses means that no one, and I mean no one, is allowed to touch our slit lamps!

Personally, I believe refraction itself can be delegated, but prescribing cannot. The art of writing a prescription involves understanding and interpreting the patient's refractive responses in the context of their complete ocular and systemic history, while refraction can be performed by any trained individual using standard equipment. Chances are, you are the best one in your practice to understand your patient's unique needs and therefore should be the one to interpret.

DIVIDE AND CONQUER

In these times of having to “do more with less,” “work smarter, not harder” and any other current business cliché you'd like to add, it makes sense to delegate more—and more smartly. Reserve your

time for the parts of the fitting process that require your expertise in particular. Below, I explain using the example of disposable soft lenses for healthy patients.

With contact lenses, “fitting” can be thought of as choosing a lens that is most appropriate in terms of meeting the needs of a particular patient. After the selection is made, lens performance is evaluated and, if deemed satisfactory, the lenses are then dispensed. Lens performance is typically re-examined during a follow-up; timing after the initial appointment varies depending on the patient, lens and the doctor's clinical bias.

So, which part of the above scenario can be delegated? In my view, all of it. (State laws may vary, so be sure to check yours.)

• *Choosing the lens type.* While this part would seem to be the most difficult to delegate due to the wide variety of lens types available, in reality it's the easiest.

For routine, non-pathology cases, many of us have a “go-to” contact lens. If you were to ask your staff, “Which lenses do you think I'd pick for a patient who is -2.00 OU with 44K's, in perfect health with great eye and systemic history?,” you will likely get the same lenses you would have chosen. This is because your staff has probably seen you prescribe your “go-to” lens of choice—and been successful—so many times, that they'll choose the same one. Even if you do not let your staff choose the lens, this part of the fitting process happens in a nanosecond

anyway, so it's something you can easily relay to your staff.

• *Evaluating the fit.* The thought of delegating this part of the process usually draws the most ire from doctors but, again, if you approach it logically, it shouldn't. You were trained to properly evaluate how a lens fits, and you can train someone else to do it. And honestly, the quality of lenses we have available today is so improved over what you may remember from optometry college that if you choose the correct lens in the step above, it's going to fit most of the time.

If for some reason it doesn't, your staff can be trained to pick the next logical choice, just like you were. Is the lens too big? Pick a smaller one. Is it too tight? Pick a looser one. Is the VA not what you expected, or is the patient uncomfortable? Again, you were trained to problem-solve and there's no reason you can't train someone else. Of course, in trickier cases, you may need to step in, but the majority of the time, properly trained staff should be able to do just fine.

• *Discharging the patient.* This is the part that I believe equates to prescribing based off of a technician's refraction, as discussed earlier. At this point, you can simply double check the fit and acuity if necessary before releasing the patient. The heavy lifting—running back and forth between the stock room and exam room, taking the lenses in and out, waiting for the lenses to equilibrate and evaluating them—has already been done. RCCL

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REFERENCE: **1.** Brennan NA. A Model of Oxygen Flux Through Contact Lenses, Cornea 20(1):104-108, 2001. **2.** Bergmanson J. Clinical Ocular Anatomy and Physiology, 14th ed. Houston, Texas: Texas Eye Research and Technology Center; 2007. **3.** Twenty-two subjects participated in a randomized, double-masked, contralateral eye study to evaluate water loss of Biotrue® ONEday, 1-Day ACUVUE MOIST, and 1-Day ACUVUE TruEye. After 4, 8, 12, and 16 hours of wear, lenses were removed and immediately weighed (wet weight). The lenses were then completely dried and reweighed (dry weight). The percent water loss was then calculated for each lens from the wet and dry weights.

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Replacement Schedule

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