We are fortunate to have a broad range of IOL options in Europe, including many types of presbyopia-correcting IOLs. In this somewhat crowded field, properly evaluating new lenses and deciding which one is best suited for an individual patient can be challenging.

With few exceptions, today's manufacturers produce IOLs from high-quality materials that allow the creation of edge designs that protect against epithelial cell migration. Some design features have become so broadly available that they no longer play a crucial role in our decision-making, like the 360° square-edge design of most posterior chamber IOLs. Haptic design, however, remains an important criterion for toric IOLs because of the haptics' role in rotational stability.

ADOPTING PRESBYOPIA-CORRECTING IOLs

We have a preference for premium lenses (eg, multifocal, trifocal, toric) based on IOL platforms that are known to us already. If the basic lens model performs well, then the premium model will also usually perform well. Beyond this, we look primarily at two factors in deciding whether to adopt a new presbyopia-correcting IOL: optical quality parameters and performance of the IOL at various distances and lighting conditions.

Optical quality parameters. At our center in Heidelberg, Germany, we have access to optical bench testing equipment. Using validated eye models, optical bench testing can predict the optical performance or sharpness of images viewed through an IOL at any distance, from a few centimeters to optical infinity, at different pupil sizes. The better the initial optical performance of an IOL, the more degradation of image quality a patient can tolerate before needing spectacles. An IOL with high-quality vision will also perform better across a wider range of defocus and may be more forgiving of mild residual refractive error or decentration. For example, the higher the modulation transfer function (MTF) value, the more contrast is transferred to the image, resulting in greater contrast sensitivity.

Optical bench testing also helps to characterize the optical aberrations inherent to any lens material, which affect the quality and range of vision that is possible with an IOL made from that material. For example, we are realizing the importance of chromatic aberration (CA), which occurs when individual wavelengths of light are out of focus, causing blur and reduced contrast sensitivity. The average eye has approximately 2.00 D of longitudinal CA between 400 and 700 nm and 0.80 D between 500 and 640 nm.\(^1\) Achromatic IOL technology (ie, materials with a high Abbe number) can correct longitudinal CA and, especially when combined...
THE FIRST BIOANALOGIC IOL

The WIOL-CF lens can extend depth of focus.

By Laura Straub, Editor-in-Chief

Developed to resemble the properties of the natural crystalline lens in size, material, shape, and function, the Wichterle IOL—Continuous Focus (WIOL-CF; Medicem) is among the recent group of extended depth of focus IOLs to hit the market. The company calls its lens a bioanalogic polyfocal IOL, intended for the treatment of cataract and presbyopia in patients who demand supreme visual acuity in the intermediate and distance ranges and who wish to maintain or restore their vision in the near range. The WIOL-CF has a 9-mm optic, is made of a soft hydrogel to enable shape change and accommodation, and has a natural pupillary influence on focus.

Figure 1. The WIOL-CF is resistant to posterior capsular opacification and adheres closely to the posterior capsule.

SPIN-CASTING TECHNOLOGY

Instead of lathe-cutting and polishing or cast molding, the WIOL-CF IOL is manufactured using spin-casting technology.

The IOL’s shape is created by spin-casting technology, whereby the lens is rotated in the mold; because no mechanical cutting or polishing is used during the manufacturing process, the lens is very smooth. Like the crystalline lens, the surface of the WIOL-CF has a negative charge mediated by carboxylate groups.

The negative charge and the lens’ smooth surface ensure that the WIOL-CF is resistant to posterior capsular opacification, as the convex hyperbolic surface closely adheres to the posterior capsule (Figure 1).

CLINICAL RESULTS

According to company literature, long-term results (2–9 years; average, 5.6 years) from 40 patients implanted with the lens are available. Mean binocular UCVA for near, intermediate, and distance vision was 0.36, 0.12, and 0.01, respectively, and more than 97% of patients scored their social functioning at 99 of 100 and spectacle independence at 98 of 100.1


with correction of spherical aberration, enhance retinal image quality without negatively affecting depth of focus (Figure 1).2,3

Clinical performance. Data on an IOL’s performance on the optical bench can be complemented by data on that IOL’s clinical performance at various distances and lighting levels and its ability to meet a given patient’s visual demands.

We take great care in evaluating patients’ typical reading distances. We seat patients at a computer and ask them to place the monitor where it would be in their home or office, and we have them hold a book or handheld electronic device to measure their reading distance. Through questionnaires and patient history forms, we also determine how much time they spend at different visual distances for work, hobbies, and daily activities.

It is not uncommon today for so-called near vision tasks to be at what we would in the past have considered an intermediate distance. For example, patients may be working on a laptop or using a tablet or smart phone at 60 cm instead of holding a book at 30 to 40 cm. We see this reflected in the growing popularity of low-add multifocal IOLs, with add powers of 1.50 to 2.75 D instead of the traditional 3.00 to 4.00 D.

We also want to know about halos and glare. In patients who drive at night or have high retinal function, and will therefore be more likely bothered by photic phenomena, choosing a lens with less risk of these side effects may take precedence over all other considerations.

Pupil independence is another important factor to consider in matching the IOL to the patient. Someone who expects spectacle independence but works in low lighting conditions, for example, is likely to be dissatisfied with a pupil-dependent IOL.

Pupil independence is a function of optics and lens material, not necessarily lens design. Diffractive multifocal, trifocal, and extended range of vision IOLs can be either pupil-dependent, as with the AcrySof Restor (Alcon) and Hoya’s extended depth of focus IOL (Gemetric), or pupil-independent, as with the Tecnis Multifocal (Abbott Medical Optics) and the AT LISA tri (Carl (Continued on page 55)
The IC-8 IOL can improve near and intermediate vision without sacrificing distance vision.

By Robert Edward Ang, MD

As a researcher, I am fascinated by new technology and have focused my interest on presbyopia treatments through participation in studies of corneal inlays; accommodating, multifocal, and extended depth of focus IOLs; and cornea-based procedures. Based upon the success of the small-aperture concept demonstrated by the Kamra corneal inlay (AcuFocus), I was interested in the potential to expand the concept and technology to my cataract patients.

MINIMIZED COMPROMISE

I have tried many presbyopia treatments and have learned that there is always something to gain by presbyopia correction—but not without some sacrifice. The most common complaint of patients, especially those with multifocal IOLs, is photic phenomena, including glare and halos. On the other hand, the most often reported downside of accommodating and extended depth of focus technologies is inadequate near vision. The IC-8 small-aperture IOL (AcuFocus; Figure 1), a one-piece hydrophobic acrylic lens, seems to minimize these shortcomings and provide adequate near vision.

STUDY RESULTS

- In nine patients implanted with the IC-8 IOL, mean near UCVA was J2 and mean intermediate and distance UCVAs were 20/20 at 1-year postoperative.
- With the IOL implanted, diagnostic testing was completed successfully with only minor adaptations.

To date, I have implanted the IC-8 in the nondominant eye in nine patients with cataracts following standard phacoemulsification. At 1-year postoperative, mean near UCVA in these patients is J2, and mean intermediate and distance UCVAs are each 20/20. I asked patients to compare their pre- and postoperative vision and rate symptoms such as fluctuating vision, distortion, glare, halos, night vision, and overlapping images; all of their responses indicated minimal side effects. I also asked patients to compare these factors with their untreated eye, and all reported similar or better results in the IC-8 eye than in the fellow eye.

A retina specialist and four technicians of varying experience levels assessed the ease of performing visual field, fundus photography, and retinal OCT examinations with the IC-8 in place. All reported that they were able to complete the diagnostic testing successfully with only minor adaptations.

AN EYE TOWARD THE FUTURE

The small-aperture principle seems to work regardless of the presence of corneal irregularity. The IC-8 lens provides an alternative in situations in which I am hesitant to use a multifocal IOL. Having technology with the ability to improve near and intermediate vision without sacrificing distance vision is exciting, and, in time, I expect the indications to grow.


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- Financial disclosure: Clinical investigator (AcuFocus)
By Pavel Stodulka, MD, PhD

Because adding the FineVision trifocal IOL (PhysIOL) to our armamentarium revolutionized our refractive practice, I have been sure to keep a close eye on other new trifocal IOL designs.

ACTIVE-DIFFRACTIVE OPTIC

I have had positive experiences with VSY’s other products, and, therefore, when the company announced its entrance into the trifocal IOL market with the RevIOL Tri-ED (Figure 1), I was happy to give it a try. It is a plate-haptic hydrophilic acrylic IOL with a trifocal diffractive structure on its anterior surface. The combination of an active-diffractive optic structure with proprietary curvature and slightly negative asphericity results in extended depth of focus for presbyopic patients (Figure 2). According to the company, the diffractive zone design creates higher modular transfer function values between the near to intermediate and intermediate to distance focusing areas compared with monofocal, bifocal, and other trifocal IOLs and clearer vision at all distances.1 The active-diffractive optic also protects the retina by blocking pale blue light.

Because we do not yet have a true accommodating IOL, I like VSY’s idea of developing the trifocal concept further. The selected disparity between near and intermediate focus (3.00 D of add for near and 1.50 D for intermediate) seems to work effectively to create sharp vision at all distances.

We are currently assessing the defocus curve and clinical results with the RevIOL Tri-ED. Initial results with this lens seem promising, and my patients have been enjoying spectacle independence in their usual daily activities. I expect more new trifocal IOLs will enter the market soon.

1. Data on file with VSY.

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Zeiss Meditec) IOLs. Some pupil-dependent lenses reduce glare and halos, which is a positive characteristic for sharp distance vision at night; however, the tradeoff is that these lenses sacrifice near acuity in dim light.

All of these issues must be factored into the selection of an IOL that will best suit the patient. A pupil-dependent IOL that provides crisp distance vision and minimal night vision disturbances may be a good choice for a nighttime taxi driver but not for a mechanical engineer who wants to be spectacle-free while working in a poorly illuminated facility.

**PUTTING IT ALL TOGETHER**

We recently had the opportunity to evaluate the Tecnis Symfony IOL (Abbott Medical Optics; Figure 2), the first lens to rely on an echelette design for an elongated depth of focus, resulting in an extended range of vision. In essence, instead of splitting light into two or three focal points, the IOL spreads the focal point wider, so that there is a clear image over a range of vision. Defocus curves for this IOL depict an extended range rather than distance and near peaks; however, the tradeoff is some loss of acuity in the very near range. (Editor’s Note: Several other IOL technologies dedicated to extending depth of focus are described in detail in the accompanying sidebars.)

Current studies have shown a clinically significant increase in range of vision with the Tecnis Symfony compared with the Tecnis monofocal (ZCB00). A sustained mean BCVA of 20/20 or better was reported through 1.50 D of defocus with the Symfony, with a 1.00 D increase in the range of vision throughout the defocus curve.4

The optic material of this lens corrects for both spherical and chromatic aberration, correcting for at least 0.75 D of lateral CA compared with the phakic eye and providing a high-quality retinal image. Like the other IOLs on the Tecnis platform, the Symfony is pupil-independent, with little degradation of near and intermediate acuity in dim light.

In my limited experience with the IOL, which includes four eyes to date, distance BCVA always remains unchanged or improved after surgery. At the final follow-up visits, distance visual acuity is 20/20 or better in the majority of eyes. Additionally, there have been no significant complaints of visual disturbances.

Unlike multifocal IOLs that create a fixed number of focal points, the Symf ony has provided my patients with continuous sharp vision from distance to near. The lens has provided improved contrast sensitivity and sharper distance vision compared with other pupil-dependent multifocal IOLs that I have used. I plan to analyze a larger series of patients with longer follow-up.

**HIGH PATIENT SATISFACTION**

**The Symfony IOL provides sharp vision from distance to near.**

By Aylin Kılıç, MD

Today’s patients expect almost perfect vision after cataract surgery. They want to see near without glasses, and they desire comfortable vision without any complications such as halos and glare.

Because the Symfony IOL (Abbott Medical Optics) is pupil independent, quality of vision does not change as the pupil expands in dark conditions. For those who drive at night or enjoy hobbies typically done in poor light, pupil independence is important.

Although multifocal IOLs continue to undergo modifications to enhance distance and near vision, unwanted side effects are still problematic. The Symfony IOL does not cause any disturbance in distance vision and can compensate for chromatic aberrations between the shorter blue and longer red wavelengths. This is because the lens does not have multiple focal points, as other multifocal IOLs do. When light approaches an echelette grating surface, as on the Symfony’s optic, it is diffracted into specific directions that vary according to step height and area. The design of the Symfony, therefore, provides an extended range of vision to the patient without producing glare and halos.

**NO DISTURBANCES**

- The Symfony IOL can compensate for chromatic aberrations between the shorter blue and longer red wavelengths.

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By Aylin Kılıç, MD

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light. The echelette design reduces the incidence of glare and halos to monofocal IOL levels.5

CONCLUSION

In our practice, the Tecnis Symfony lens will likely be a good choice for patients who want excellent UCVA for distance and intermediate-near tasks and those with high retinal function or night driving demands who would be bothered by glare and halos. Patients who do not need good vision in dim light, have heavy true near visual demands, and do not want to wear reading glasses even for fine print might be better served by a multifocal IOL. With the availability of more presbyopic IOL designs, surgeons should be aware of the performance characteristics of different lens features in order to truly customize lens selection for each patient.

4. 166, Data on File. Extended Range of Vision IOL 3-Month Study Results (NZ).
5. Auffarth GU. Clinical experience with an extended range of vision 1-Piece IOL. Paper presented at: the XXXII Congress of the ESCRs; September 13-17, 2014; London.

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