USING PRESBYOPIA & TORIC LENS Technologies to Achieve OPTIMAL CATARACT REFRACTIVE Outcomes

Supported by an unrestricted educational grant from
To achieve optimal vision and patient satisfaction with presbyopia-correcting intraocular lenses (IOLs), surgeons need to match available technologies with patients’ visual needs.

Patients typically need three distances: 40cm for reading, 80cm for intermediate vision and distance vision. To achieve all three, we may use a multifocal IOL and reading glasses for long-term reading and small print. If patients want good intermediate vision and are willing to wear reading glasses for long-term reading and fine print, options include extended depth of focus (EDOF) IOLs, mini-monovision, and low-add multifocal IOLs. However, glare, halos, and starbursts can occur with multifocal IOLs.

The advantages of EDOF IOLs include good distance vision, good intermediate vision and less reduction in contrast sensitivity compared with multifocal IOLs. Patients also may see less halos. They will be less spectacle dependent but not completely free of glasses. EDOF IOLs are more forgiving of residual refractive errors if biometry and power calculations are not precisely on target. However, near vision will not be as good as it is with multifocal IOLs, and patients may have some dysphotopsia.

The Symfony (Johnson & Johnson Vision) was the first EDOF IOL to come to market, and I was involved in prototyping the lens. We combined it with micro-monovision (0.5 to 0.75D).

The Symfony has an echelette zone in front, providing an extended focus range. It also has rings that correct chromatic aberration, enhancing contrast sensitivity.

The advantages of EDOF IOLs include good distance vision, good intermediate vision, and less reduction in contrast sensitivity compared with multifocal IOLs.

**Advantages**
- Good distance vision
- Good intermediate vision (computer)
- Less reduction in contrast sensitivity
- Less halos
- Limits spectacle dependence
- More forgiving of residual error

**Disadvantages**
- Near vision lower than with multifocals
- Some dysphotopsias

EDOF technology provides good binocular uncorrected distance and intermediate visual acuity. We can achieve a good degree of spectacle independence if combined with micro-monovision of 0.5 or 0.75D, and patients may be less critical of their refractive outcomes.

I have not observed disturbing dysphotopsia, but we tell patients that they will need reading glasses for lengthy reading periods or small print and in dimly lit environments. I ask patients to sign a statement confirming that they understand that.

When implanting EDOF IOLs, we need to under-promise and over-deliver, because quite a few patients who receive these IOLs will not need glasses if all goes well.

**CONCLUSION**

EDOF technology offers extended range of focus. It has far dominant light distribution. Most light goes to distance, and there are two power additions, creating an optical bridge effect to EDOF.

Using a special simulator, we can examine different distances and measure the defocus curve and contrast sensitivity. When defocus curves are examined, the monofocal IOL drops off at near and the LARA maintains a plateau and then drops off.

The LARA has classical diffractive grading called Smooth Microphase technology, which reduces glare. In the simulator, with a different pattern of rings, there is slightly more dysphotopsia with a trifocal IOL than with the EDOF IOL. It is optimised for chromatic aberration.

Other IOLs are being investigated, such as the Lentis Comfort (Oculentis), Instant Focus (InFo, Swiss Advanced Vision), Precizon Aspheric Presbyopic IOL (Opttec), IC-8 MONO EDOF IOL (AcuFocus), Mini Well Ready (SIFI Medtech) and bioanalogic WIOL-CF (Medicem).

**Figure 1**

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*By Oliver Findl, MD, MBA*

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**The advantages of EDOF IOLs include good distance vision, good intermediate vision, and less reduction in contrast sensitivity compared with multifocal IOLs**

– Oliver Findl, MD, MBA

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Using **Presbyopia** and Toric Lens Technologies to Achieve Optimal Cataract Refractive Outcomes

**Symfony Case**

A patient wrote to me requesting a Symfony toric IOL and had previously consulted several other surgeons. He acknowledged that he was a demanding person.

His preoperative refraction was: OD, -14.0D +1.75D cylinder 80 degrees (dominant eye); OS, -13.0D +0.5D cylinder 110 degrees. Best-corrected distance vision was 43 letters in the right eye and 37 letters in the left. We selected the Symfony +7.5D ZXT375 for the right eye and +6.5D ZXT375 for the left.

During the procedure, as I performed routine polishing of the posterior capsule with a 30-gauge cannula, I noticed a small break in the posterior capsule. I was injecting BSS with a syringe and then exchanging against viscoelastic, hoping the vitreous would not prolapse. Using a 23-gauge crocodile forceps, I converted the tear to a small eccentric posterior capsulorrhexis because we were implanting a toric Symfony IOL and could not use a sulcus lens. I performed a small vitrectomy with a low bottle height to avoid introducing too much BSS into the eye. We performed surgery on the fellow eye one week later. Figure 1 shows both eyes one hour after surgery.

Two years after surgery, his refraction was: OD, 0.0D +0.75D cylinder 170 degrees; OS, -0.5D +1.25D cylinder 5 degrees. Uncorrected distance visual acuity was: OD, 51 letters; OS, 47 letters; best-corrected distance visual acuity was: OD, 52 letters; OS, 49 letters. His lenses were well centred, with no posterior capsule opacification (Figure 2).

When he completed the questionnaire, he was very satisfied with his daytime and night-time distance vision, he was satisfied with his intermediate distance vision at the computer and he was mildly satisfied with his close vision while reading.

*Oliver Findl, MD, MBA*
All patients were completely spectacle independent for far and intermediate distance, and 12% occasionally needed glasses for near.

NOVEL MULTIFOCAL IOL

The AcrySof IQ PanOptix IOL (Alcon), a trifocal IOL, is made of hydrophobic acrylic material and is a single-piece IOL. It has a larger central zone and provides a third focal point, as well as a fourth focal point for distance.

We initially implanted this IOL in two patients, who had very good outcomes, so we performed a study in 54 eyes of 27 patients. Three months after surgery, patients’ optical quality was good, and vision was good at near, intermediate and far, but patients reported slight halos.

When Prof. Dr. Rudy Nuijts compared defocus curves for the ReStor, FineVision and PanOptix, the PanOptix showed a more continuous range of defocus.5

Using Trifocal IOLs to Correct Presbyopia

According to the 2017 ESCRS Clinical Survey, use of bifocal intraocular lenses (IOLs) is decreasing compared with 2016 results (34% in 2016 vs. 25% in 2017), whereas the use of trifocal IOLs is increasing (39% in 2016 vs. 45% in 2017) (Figure 3).

Among bifocal IOLs, diffractive IOLs have been the best choice. However, when we look at the defocus curve for the +4D add AcrySof ReStor diffractive bifocal IOL (Alcon), it shows curves for distance and near vision but a gap for intermediate vision.

EVOLVING MULTIFOCAL IOLS

Gatinel et al. performed optical bench comparisons of monofocal and bifocal IOLs and a trifocal IOL.1 The aspheric trifocal diffractive IOL, FineVision (PhysIOL), had a +3.5D and +1.75D add and showed an intermediate peak not observed with the other IOLs in the study.

Alió et al. implanted the FineVision trifocal IOL in 40 eyes in 20 patients with cataracts. Patients showed good intermediate, distance and near vision.2

The AT LISA tri839MP (Carl Zeiss Meditec) trifocal diffractive IOL, made of hydrophilic acrylate with a hydrophobic surface, has a +3.33D near add and +1.66D intermediate add and negative spherical aberration.

We studied this lens in 54 eyes in 27 patients.3 Three months after it was implanted bilaterally, the spherical equivalent was close to emmetropia. The mean spherical equivalent was 0.05 ± 0.32D and cylinder 0.32 ± 0.33D. Uncorrected distance visual acuity was -0.1 ± 0.1 logMAR uncorrected intermediate visual acuity 0.0 ± 0.1 logMAR and uncorrected near visual acuity 0.0 ± 0.1 logMAR. Sixty percent had halos.

Patients were happy with their optical quality, and on a survey of patient satisfaction they were very satisfied, except their experience driving at night was less favourable. Ninety-two percent of patients would choose the same IOL again. All patients were completely spectacle independent for far and intermediate distance, and 12% occasionally needed glasses for near.

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What type of presbyopia-correcting IOL technology is used in the majority of your presbyopia correction patients?
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We performed a comparative analysis of a monocular PanOptix IOL and monocular AT LISA IOL and found that both provided 0.2 logMAR or better vision between +0.5 and -3.0D; however, the PanOptix provided significantly better visual acuity at 50 and 66 cm and might be more suitable for patients with closer vision requirements at 60 cm compared with the AT LISA at 80 cm. Both IOLs showed comparable contrast sensitivity, high spectacle independence and high patient satisfaction despite some optical phenomena.

CONCLUSION
Among our premium IOLs, we currently use 38% monofocal IOLs and more than 60% trifocal and extended depth of focus IOLs. There are advantages of both presbyopic IOLs. Trifocal IOLs show high patient satisfaction with very good distance, intermediate and near visual acuity, providing vision that is closest to the natural defocus curve (Figure 6). However, optical phenomena occur with multifocal IOLs. When implanting trifocal IOLs, an optimal emmetropic result is necessary.

At the moment, we have three models, and the trifocal IOL provides good presbyopia correction.

REFERENCES

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V = Visit: 1st visit = 1st day post-op, 2nd visit = 1st day post-op 2nd eye, 3rd visit = 1st week post-op 2nd eye;

a = OD: 1 week post-op, OS: 1st day post-op
b = OD: 3 weeks post-op, OS: 10 days post-op
c = OD: 1st day post-op, OS: 3 days post-op

TRIFOCAL IOLs

- 3 IOL Models
  - PhysIOL, Zeiss AT LISA Tri, Alcon PanOptix
- Pros
  - High patient satisfaction with very good distance, intermediate and near visual acuity
  - Closest to natural defocus curve
  - Main advantage of trifocal technology
- Cons
  - Principle of multifocal IOL technology: optical phenomenon
  - However, often disregarded by patients because of visual continuum
  - Optimal (emmetropic) result necessary
  - Biometry, capsulotomy, centration

Figure 5

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With advances in surgical and diagnostic technology, we are much closer to eliminating residual refractive error after cataract surgery — Boris Malyugin, MD, PhD

**Preoperative Tools and Diagnostics: Improved Treatment Planning for Toric IOLs**

**Technologic advances enable greater diagnostic precision**

**Boris Malyugin, MD, PhD**

If we precisely predict spherical refractive error and minimise residual astigmatism during cataract surgery, we are more likely to achieve excellent visual acuity and patient satisfaction.

Figure 7 shows the incidence of corneal astigmatism in patients with cataracts.

**ASTIGMATISM ASSESSMENT**

Keratometry allows us to determine the difference between the flat and steep axis, as well as the power of astigmatism, but corneal topography must be used to determine corneal regularity, symmetry and orientation of the steep axis and to identify irregularities. Tomography allows us to assess the anterior and posterior surfaces.

New biometry devices combine axial length measurements with corneal astigmatism assessment. Each is slightly different. For example, the Verion (Alcon) measures a 1.9mm central zone. IOLMaster 500 (Carl Zeiss Meditec) measures a 2.3mm central zone and LenStar (Haag-Streit) has two lines of light reflection measuring from 1.65-to-2.3mm.

If anterior corneal astigmatism exclusively is used to calculate IOL power, without considering posterior corneal astigmatism, patients who have with-the-rule (WTR) astigmatism have hypercorrection of approximately 0.5D and those who have against-the-rule (ATR) astigmatism have hypocorrection of approximately 0.3D.3

Posterior corneal astigmatism can be assessed by direct measurements with Scheimpflug, optical coherence tomography (OCT), colour LED and intraoperative refractive biometry.

IOL power calculation errors can result from the effective lens position, K reading, axial length and other factors.6

Effective lens position can be predicted with later-generation formulas like Haigis and Holladay 2. Several factors influence effective lens position: axial length, average K, horizontal white-to-white, refraction and others.

Swept-source OCT biometry allows us to measure axial length precisely. Research shows 96% of patients with dense cataracts can be effectively measured with swept-source OCT.5

**CONCLUSION**

With advances in surgical and diagnostic technology, we are much closer to eliminating residual refractive error after cataract surgery. However, additional work is necessary to achieve this goal.

**REFERENCES**


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Intraocular lens (IOL) alignment significantly impacts postoperative outcomes after cataract surgery or refractive lens exchange. Exact placement of the toric IOL on the steep meridian is critical. In a study we performed, the mean misalignment was 4.0 degrees (standard deviation, 3.5 degrees), with outliers as great as 17.0 degrees, and 50% of final IOL positions were within 3 degrees of the targeted meridian. If an IOL is misaligned by 10%, 33% of the toric effect of the IOL will be lost.

CAUSES OF MISALIGNMENT

One reason for misalignment is cyclotorsion, which may occur when the patient is in the supine position (average, 4 degrees; maximum, 17 degrees). It also may be difficult to identify the horizontal meridian when the patient is draped because we cannot see the fellow eye (Figure 8). Consequently, we perform marking while the patient is sitting, which is the same position used for measurements.

Conventional marking techniques include marking at the slit lamp; the beam is positioned horizontally and two small microerosions are made with a needle at the limbus or cornea close to the limbus.1 Other devices include a pendulum marker, tonometer marker or bubble marker.

When we evaluated four manual marking techniques in 60 patients, we found that the slit lamp and pendulum markers performed best.1 Therefore, we use these two techniques for manual marking in our practice.

A study looking at manual marking steps—reference axis marking, alignment axis marking, and IOL alignment—reported that differences at each step can add up to a total difference of approximately 5 degrees.2 Furthermore, additional rotation may occur after surgery in certain patients.

AUTOMATED MARKING

One option is to use automated marking systems (Figure 9). The IOLMaster (Carl Zeiss Meditec) provides a reference image for intraoperative toric IOL alignment. The image and keratometry data are transferred to the Callisto Eye (Carl Zeiss Meditec), and preoperative marking is not necessary. With version 3.5, intraoperative alignment was successful in 100% of cases. Precision was high, within 1 degree.

When we looked at outcomes of 30 cases one hour after surgery, alignment was close to zero.
Managing Postoperative Error in Toric IOL Patients: Pearls for Success

To achieve optimal results from toric IOLs, surgeons need to know how to prevent and correct residual astigmatism.

Rudy M. M. A. Nuijts, MD, PhD

Despite advances in intraocular lens (IOL) technology, we still have significant room for improvement to achieve optimal refractive outcomes from cataract surgery. My colleagues and I performed a randomised clinical trial several years ago showing that 54% of eyes receiving toric IOLs had more than 0.5D of postoperative residual astigmatism. In another series, the incidence of residual astigmatism exceeding 0.5D was more than 50%.

When we looked at our cohort of with-the-rule (WTR) astigmatic patients, we found that the higher the lens power, the more overcorrection occurred. However, in against-the-rule (ATR) astigmatism, patients did well independent of the IOL power.

Sources of Residual Astigmatism

Causes of residual astigmatism include posterior astigmatism, preoperative measurement errors, marking errors, IOL misalignment, effective cylinder power and surgically induced astigmatism. As anterior astigmatism increases, so does surgically induced astigmatism.

On average, posterior astigmatism is approximately -0.3D and in 9% it is more than 0.5D. Posterior corneal astigmatism decreases total corneal astigmatism in WTR anterior astigmatism and increases total corneal astigmatism in ATR anterior astigmatism.

In our cohort of patients who received toric IOLs, in WTR astigmatism there was a moderate correlation between anterior and posterior astigmatism and with ATR astigmatism there was a weak correlation between anterior and posterior astigmatism.

Abulafia et al. reported the Barrett calculator best predicted the lowest level of residual astigmatism. Most companies have integrated the Barrett toric calculator into their company-based calculators.

When we looked at the incidence of misalignment in our cohort, 5- to 10-degree misalignment occurred in 4% of eyes and more than 10 degrees in another 4%.

IOL misalignment reduces the effect of the toric IOL. We can improve lens positioning with digital marking, but it does not yet translate into better outcomes in terms of uncorrected vision and less residual astigmatism.

Correcting Residual Astigmatism

Residual astigmatism may be corrected by repositioning the IOL, performing an IOL exchange or laser touchup or creating arcuate incisions with a femtosecond laser. However, we need to identify the cause of residual astigmatism to choose the best way to correct it.

The Berdahl and Hardten Toric Results Analyzer (https://astigmatismfix.com/) helps us determine the impact of realigning an IOL. The Barrett Rx Formula – Outcome Analysis (https://
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www.apacr.org/barrett_rx105/) provides information on rotation and lens exchange.

Figures 8 to 10 show a referred postoperative case (Case 1). The IOL was repositioned, but the IOL tilted because of an eccentric capsulorrhexis; a LASEK touchup was performed successfully.

CONCLUSION

To prevent residual astigmatism, surgeons should use their surgically induced astigmatism value when calculating the toric IOL, use a second-generation toric calculator that incorporates posterior astigmatism and effective lens position, recognise that surgically induced astigmatism and posterior astigmatism depend on the amount of anterior astigmatism and consider that digital marking may increase predictability.

To correct residual astigmatism, we first need to determine the cause. If the lens is misaligned, we need to simulate whether rotation could improve the outcome. The decision to rotate or exchange the IOL depends on the amount of ametropia and residual astigmatism. If the error is greater than 1.25D, exchange usually is preferred. Surgical correction is not common in our database.

When we looked at our cohort of with-the-rule astigmatic patients, we found that the higher the lens power, the more overcorrection occurred

— Rudy M. M. A. Nuijts, MD, PhD

REFERENCES


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