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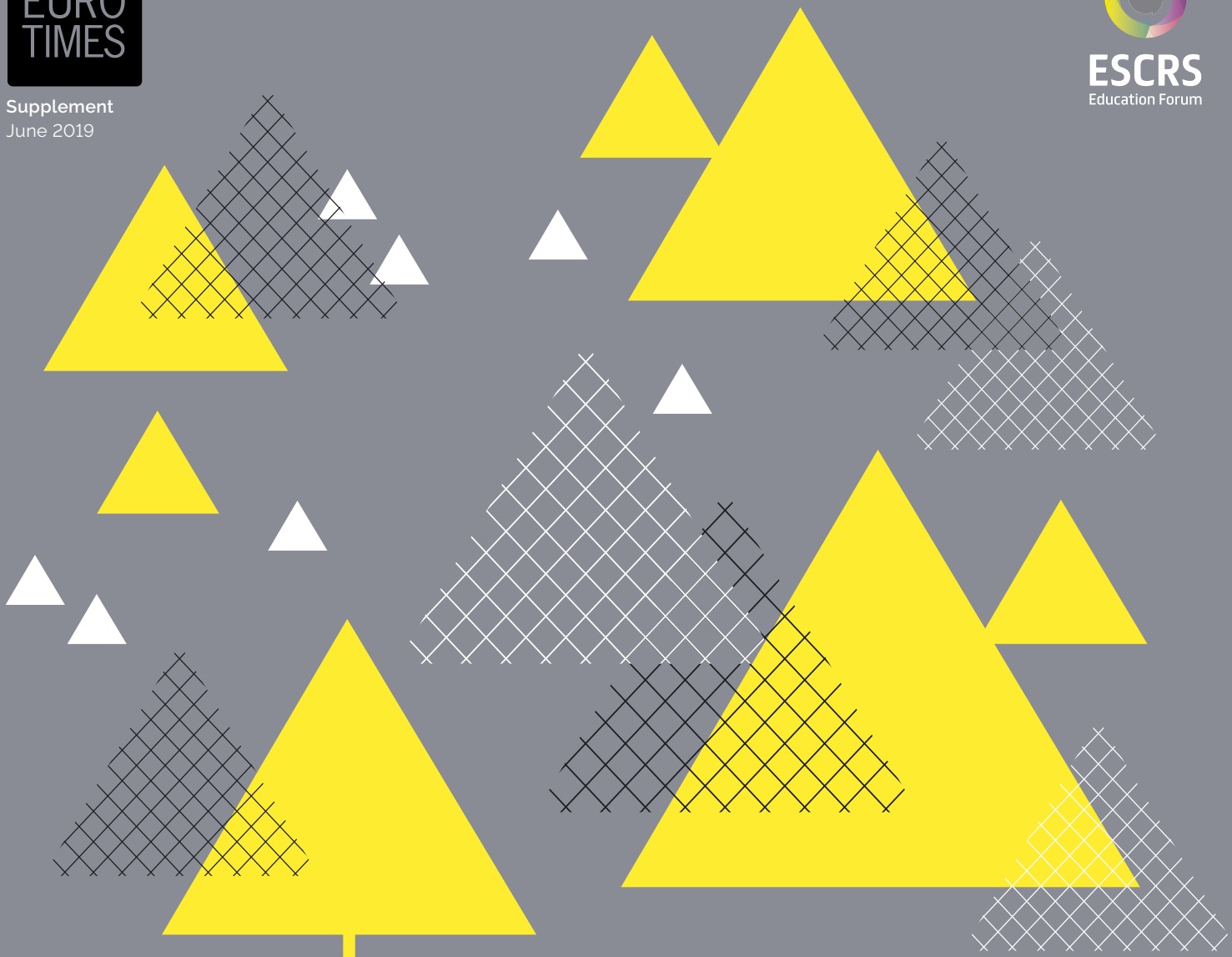

IMPROVING
— outcomes —
WITH
Refractive IOLs

Treatment Planning & Postoperative Management

ESCRS Survey Reveals How Surgeons Think about Refractive IOLs

By Rudy MMA Nuijts, MD, PhD

The 2017 European Society of Cataract and Refractive Surgeons (ESCRS) Clinical Survey of eye surgeon members from Europe, the Middle East, Asia, India and beyond revealed an interesting range of thoughts and practices regarding the use of refractive intraocular lenses (RIOLs) – such as toric and presbyopia-correcting IOLs. Most of the participating surgeons said they perform fewer than 250 cataract surgeries annually, and the survey results revealed that for 80% of them, less than 10% of their cataract surgeries involve a toric or presbyopia correcting IOL. What's more, 45% of participants said they do not use toric or presbyopia-correcting IOLs for any surgeries.

After implanting a toric IOL, how many DEGREES of postoperative rotational error is acceptable before visual quality and degradation of visual acuity are significantly affected?

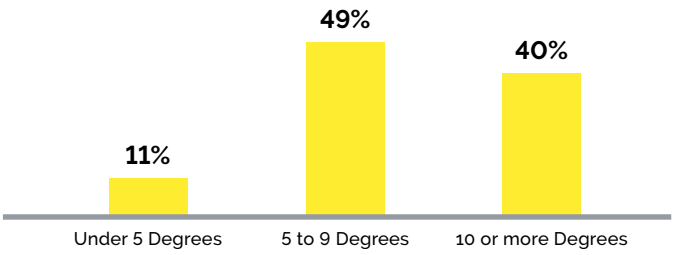

Figure 1: *Only 11% of respondents of the 2017 ESCRS Clinical Survey believe that less than 5 degrees of postoperative rotations error is acceptable before visual quality and visual acuity are significantly affected*

MATCHING IOLS TO PATIENT NEEDS

A surgeon's confidence in his or her ability to recommend the most appropriate IOL to achieve the best possible refractive outcome is key to a successful surgical plan. When asked how confident they are in their ability to match presbyopia-correcting options to patient needs with current technologies, just 20% said they are very or extremely confident, and another 30% are somewhat confident. This left 50% to reveal that they have no confidence in their ability to appropriately address the needs of their patients with presbyopia-correcting IOLs.

The acceptable degree of postoperative rotational error is a major point of concern among surgeons who rely on refractive IOLs such as toric IOLs for their patients who have presbyopia. In response to the question, "After implanting a toric IOL, how many degrees of postoperative rotational error is acceptable before visual quality and visual acuity are significantly affected?", 40% said they think more than 10 degrees of postoperative rotational error is acceptable (Figure 1). Surgeons who have more experience and greater expertise with this type of IOL would undoubtedly challenge the majority's comfort level with even 7 degrees of postoperative rotational error.

THE CONFIDENCE FACTOR

Perhaps even more noteworthy is the revelation of the number of survey participants who lack confidence in their ability to achieve the best outcome and promote patient satisfaction with respect to toric IOLs and presbyopia correction, in general. In response to the question, "How confident are you in your ability to mitigate or prevent postoperative refractive surprises and take action to manage potential dissatisfaction in presbyopia-correcting IOL patients?", 60% said they are not confident in their ability to effectively handle these two crucial elements of the refractive IOL equation.

> **A surgeon's confidence in his or her ability to recommend the most appropriate IOL to achieve the best possible refractive outcome is key to a successful surgical plan**

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> **The acceptable degree of postoperative rotational error is a major point of concern among surgeons who rely on refractive IOLs such as toric IOLs for their patients who have presbyopia**

Refractive IOL Patterns are Evolving with the Times

By Béatrice Cochener-Lamard, MD, PhD

Responses from the 2017 ESCRS Clinical Survey, of 1,800 delegates, regarding refractive IOL practice patterns and thoughts painted a picture of surgeons who are increasingly interested in toric and extended depth of focus (EDOF) IOLs, as well as in ways to circumvent barriers to their use – such as higher cost and more complex marketing. The survey, which is meant to provide evidence-based education, is performed annually.

Although refractive IOL practice patterns are evolving, monovision apparently remains the safest solution for most participants. The survey revealed that 43% of respondents' current cataract procedures are targeted for monovision or mini-monovision, while just 9% of their current cataract procedures involve presbyopia-correcting IOLs.

> Although refractive IOL practice patterns are evolving, monovision apparently remains the safest solution for most participants

What type of presbyopia-correcting IOL technology is used in the majority of your presbyopia correction patients?

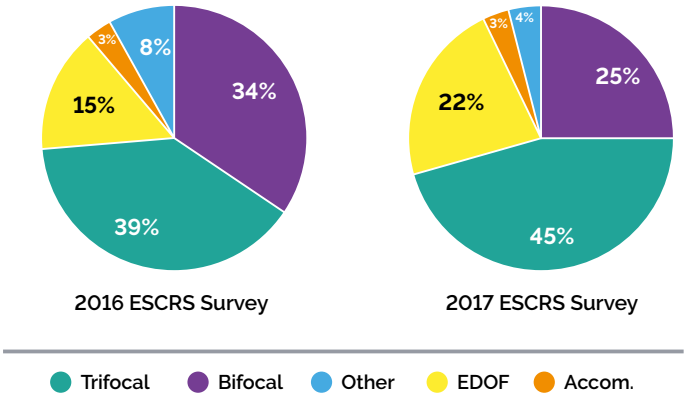

Figure 2: Growth of refractive IOL usage in EDOF and Trifocal IOLs between 2016 and 2017

> The survey also showed that 35% of participating surgeons consider anything over 0.75D of postoperative cylinder error to be visually insignificant

POST-OP CYLINDER

The survey also showed that 35% of participating surgeons consider anything over 0.75D of postoperative cylinder error to be visually insignificant, and do not believe that it is likely to have an impact on visual quality and patient satisfaction in presbyopia IOL patients. In response the question, "What amount of postoperative residual cylinder error could be considered to be visually-significant in terms of visual results and patient satisfaction?", 30% indicated that it was 0.5D or less (Figure 2).

The most popular type of presbyopia-correcting IOL technology shifted somewhat since 2016, when this survey was last performed. When queried about what type of refractive IOLs are used in their practice, respondents said trifocal IOLs were used in 39% of presbyopia-corrected patients in 2016, and that rose to 45% in 2017. The EDOF IOLs also increased from 15% in 2016 to 22% in 2017. Accommodating IOLs remained at 3%, and bifocal IOLs shrunk from 34% in 2016 to 25% in 2017. The results suggest that surgeons are still dreaming of eventually having functional accommodative IOLs with an ideal design.

TORIC IOL DECISIONS

According to the 2017 ESCRS Clinical Survey, participating surgeons said that just 11% of current cataract procedures involve toric IOLs. However, if cost was not an issue, 35% of their cataract patients with clinically significant astigmatism would receive a toric IOL. This suggests that the extra cost associated with these lenses and the fact that we have to sell them to our patients in a certain way to help them appreciate the IOL's benefits remains a key issue and a key challenge.

The final and perhaps most salient question regarding refractive IOL use was, "How are you aligning the preoperative axis (assessed with your diagnostic tools) with your intraoperative axis and where you are placing the toric IOL during surgery?" Almost half – 47% – are still using a manual strategy of ink marking with the aid of manual axial instruments, while 35% are either marking without manual axial instruments or using anatomical landmarks without preoperative marking.

Perhaps results from the 2018 ESCRS Clinical Practice Survey will show further progress with respect to trends of refractive IOL usage.

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Diagnostics and Tools for Improved RIOL Treatment Planning

By Filomena Ribeiro, MD, PhD, FEBO

When it comes to implanting refractive IOLs, every bit of information gathered and analysed preoperatively, as well as the tools and techniques employed intraoperatively and even postoperatively, are critical to effective procedure planning and a successful outcome. This includes everything from the patient's personality and motivation for choosing this surgical option to imaging devices, to biometry, keratometry, measurement validation methods and more.

PATIENT SELECTION

Patient selection is a critical part of the preoperative evaluation. A personality profile that correlates with being a good candidate for RIOL surgery includes being highly motivated for spectacle independence, a calm personality with a positive attitude, being capable of accepting the possibility of a small amount of loss of contrast and being able to accept that we cannot guarantee the procedure's results. We can use questionnaires to assess the patient's personality, their degree of motivation for choosing a refractive IOL and their lifestyle and visual demands. If we find that they have a hypercritical personality with unrealistic expectations, or if they expect perfect night driving vision, those are formal contraindications. If we deem a patient unsuitable for this surgical solution it is important to explain to them why they are not a good candidate.

> **Patient selection is a critical part of the preoperative evaluation**

ASSOCIATED PATHOLOGIES

We should always discard pathologies that can cause low visual quality and factors that may influence biometry efficacy. An example of this is dry eye, which may impact IOL calculations and cause low visual quality. Dry eye is highly underestimated despite being present in approximately 50% of cataract surgery patients. Often used therapies, such as anxiolytics, antidepressants and antihistamines, can be a causal factor.

In addition, the surgery itself can cause alterations in ocular surface quality, as well as frequent corneal incision neuropathic effect. All of this needs to be factored into the surgical plan.

DIAGNOSTIC DETAILS

Specular biomicroscopy and optical coherence tomography (OCT) can reveal critical findings regarding final quality of vision and contrast sensitivity. There is a strong correlation between the Guttate area and the deterioration of vision.[1] Also, epiretinal membranes are common in potential cataract surgery patients; in fact, a routine posterior segment OCT can reveal clinically undetectable macular pathology in up to 13% of cases.

VALIDATION INTEGRATION

In order to optimise our results, we need to always use the same principle instrument and validate measurements with more than one instrument.

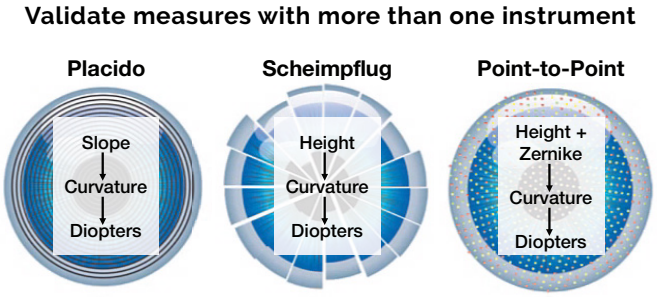

Figure 3: *Each keratometry method – Placido, Scheimpflug, and Point-to-Point – is based on different principles*

Each keratometry method is based on different principles, which gives rise to systematic differences, thus validation of all measurements – with more than one instrument – is a critical part of the planning process (Figure 3). Some calculators, such as the Barrett Toric Calculator, allow us to include input from several instruments and integrate the value. Total corneal power and astigmatism can be relevant for success. We must have a nomogram or real values to attain the predicted total astigmatism. Alternatively, we have intraoperative aberrometry to confirm our data.

To achieve the optimal outcome, surgery must be minimally invasive. We must perform a capsulorhexis for optimal centration of the IOL and account for incision-induced astigmatism. Finally, just before surgery, you should plan for how you will correct any residual error and discuss the plan with the patient, so their expectations are realistic.

> **Dry eye is highly underestimated despite being present in approximately 50% of cataract surgery patients**

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Trifocal IOLs: Lens-Based Presbyopia Correction Options

By Thomas Kohnen, MD, PhD, FEBO

The use of trifocal intraocular lenses (IOLs) has grown steadily since 2012, and today 45% of the presbyopia-correcting IOLs used in our practice are trifocal lenses. These IOLs have a high rate of patient satisfaction, and a high rate of spectacle independence, despite the presence of postoperative optical phenomena such as halo and glare. There is a significant difference in the degree of near, intermediate and distance vision quality among the various types of multifocal IOLs and intermediate vision is more prominent with trifocal IOLs.[1] These IOLs work well for patients who have clear corneas and a strong desire for spectacle independence.

TRIFOCAL PRINCIPLE

The PanOptix (Alcon), AT LISA Tri (Zeiss), and FineVision (PhysIOL) are among the trifocal IOLs currently available in Europe. With trifocal IOLs, light is distributed to multiple foci to achieve far, intermediate and near vision (Figure 4). Extended depth of focus (EDOF) IOLs, on the other hand, provide far and intermediate vision, with less near vision.[2] Reducing the intermediate dip in visual acuity (VA) while – in most cases – maintaining near vision adequate for reading gives trifocal IOLs an advantage over bifocal or EDOF lenses.

> **Despite some optical phenomena, patients had high spectacle independence 3 months postoperatively**

In a prospective, non-randomised, non-comparative case series of 27 patients undergoing implantation with a trifocal IOL, patients were very happy with their outcomes overall. The mean binocular VA was -0.1 ± 0.1 logMAR or about 20/16 at distance, and 0.0 ± 0.1 logMAR or 20/20 at intermediate and near distances. Contrast sensitivity was within normal range in photopic, mesopic and mesopic with glare conditions. Despite some optical phenomena, patients had high spectacle independence three months postoperatively; 92% of patients said they would choose the same IOL again.[3]

In a study that looked at trifocal IOLs in high myopes, we found that in highly myopic eyes with low IOL power (0.0-to-10.0D) these IOLs provided satisfactory short-term visual and refractive outcomes. The highly myopic group three months postoperatively had a mean UDVA of 0.06 logMAR, UIVA of 0.13 logMAR and UNVA of 0.12 logMAR, while the control group had a mean UDVA of -0.01 logMAR, UIVA of 0.04 logMAR and UNVA of 0.04 logMAR. Corrected distance visual acuity was 0.1 logMAR or better in all eyes.[4]

Last year we did a comparative study of a quadrifocal lens and a trifocal diffractive IOL after femtosecond laser-assisted lens surgery. This study comprised 80 patients who had bilateral implantation of an AcrySof PanOptix (panfocal) or AT LISA (trifocal) IOL. The main difference we found was in the defocus curve, with a bit of an advantage at 60cm for the panfocal lens, and we also had better visual acuity at 50cm and 66cm with the panfocal IOL.[5]

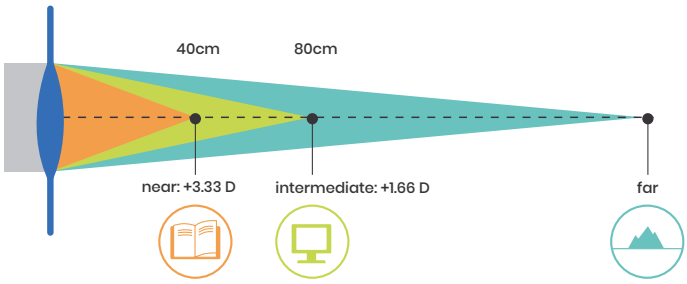

Figure 4: *Trifocal IOLs have three distinct focal points for near, intermediate and far vision*

Finally, trifocals are my first choice of multifocal IOL for patients who want spectacle independence, and now we have a trifocal add-on lens for our pseudophakic patients, so those who already have a traditional monofocal IOL can also benefit from trifocal technology.

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EDOF IOLs Offer Multifocality Minus Night Vision Problems

By Francesco Carones, MD

The technology behind extended depth of focus (EDOF) lenses addresses the inter-related concepts of quality of vision, multifocality and night vision symptoms. Unlike bifocal and trifocal IOLs, EDOF lenses provide a single focal point, and unlike monofocal IOLs, they have an elongated or extended depth of focus. The multifocality afforded by bifocal and trifocal IOLs compromises quality of vision and exacerbates night vision symptoms, whereas EDOF lenses offer a modicum of multifocality without compromising quality of vision or instigating night vision symptoms.

> **EDOF lenses offer a modicum of multifocality without compromising quality of vision or instigating night vision symptoms**

HOW IT'S DONE

Theoretical performance of EDOF IOLs provides at least 0.5D of increased depth of focus at 0.2 LogMAR (20/30), compared to monofocal IOLs (Figure 5). There are currently three different EDOF approaches: diffraction, refraction and small-aperture optics. The Johnson & Johnson Symfony is a diffractive echelette lens that elongates the focus instead of splitting the light into two or more components. Other EDOF IOLs including the SiFi MiniWell, the Medicem WIOL-CF, the SAV Lucidis and the Opthec Precizon Presbyopic all rely on refractive technology, which utilises spherical aberration, asphericity or a zonal approach to reach the same target. The Acufocus IC-8 utilises small-aperture optics technology to improve elongation of the focal point. Another method, known as the pseudo-EDOF approach, elongates the focal point adding distinct focal distances that are placed so close to one another that they mimic an extended depth of focus.

The Tecnis Symfony offers high quality uncorrected visual acuity (UCVA) at all distances. As far as night vision symptoms, the Symfony did well in both the Concerto and Harmony EDOF multi-centre studies, with less than 3% reporting severe symptoms and more than 90% reporting no or mild visual symptoms.

COMPARE AND CONTRAST

The big question is: How do these EDOF IOLs compare to currently available monofocal and multifocal IOLs? With respect to quality of vision, EDOF IOLs are better than bi/trifocal and comparable to monofocal options. As far as multifocality, EDOF offer less than bi/trifocal, but more than monofocal. And as far as night vision symptoms, EDOF are better than bi/trifocal and worse than monofocal.

EDOF IOLs show a good tolerance to unexpected refractive surprises and thus have a better optical 'sweet spot'. Another benefit is that these innovative IOLs afford a better tolerance to unexpected postoperative residual errors than diffractive bifocal and trifocal IOLs.[2]

The best candidates for these innovative IOLs want a range of vision rather than one, two or three distinct foci. They want an extended range of unaided good vision, with very good distance and intermediate. Those who opt for EDOF are aiming for minimal or no light split, with less loss of clarity and contrast acuity. They want functional vision for daily tasks that require good distance vision. They want quality vision rather than spectacle independence. They require quality intermediate vision for digital vision activities – computer, tablet or phone. Ideal EDOF candidates are more active and dynamic than the typical multifocal IOL patient, and they tend to be taller individuals and have longer arms – because people who have longer arms are not used to bringing objects to read very close to them. They are individuals who are contraindicated to trifocal IOLs but are still interested in spectacle independence.

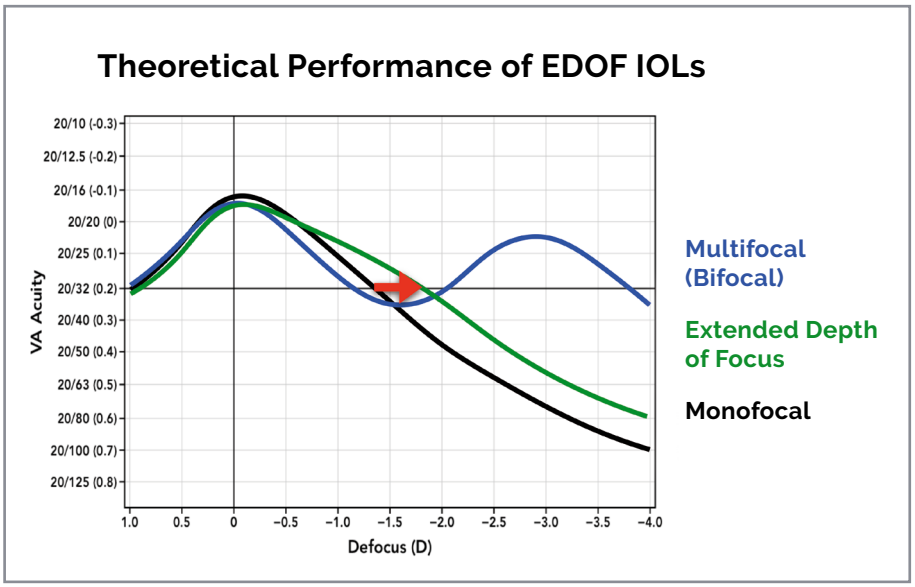

Figure 5: *EDOF IOLs provide at least 0.5D increased depth of focus at 0.2 LogMAR (20/30)*

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Presbyopia-Correcting IOLs and Astigmatism Correction

By Oliver Findl, MD

It is a common misconception that 0.75D of residual cylinder is not visually significant, when in fact that degree of astigmatism can actually cause quite a bit of trouble, particularly in the case of a presbyopia-correcting IOL. A big difference between keratometry and topography measurements before surgery is a predictor of residual astigmatism. There is no question that our measurements need to improve. If we had better measurements, we would have less residual astigmatism.

Hayashi et al. performed a study looking at the impact of astigmatism (Figure 6). In this study, eyes had implantation of a diffractive multifocal IOL with a +3.00D add (AcrySof ReSTOR SN6AD1), a +4.00D add (AcrySof ReSTOR SN6AD3) or a monofocal IOL (AcrySof SN60WF). Astigmatism was simulated by adding cylindrical lenses of various dioptres (0.00, 0.50, 1.00, 1.50, 2.00), after which distance-corrected acuity was measured at various distances. The simulation reveals reduced visual acuity (VA) in general, as well as the beginnings of degradation of near vision. Hayashi concluded that the presence of astigmatism in eyes with a diffractive multifocal IOL compromised all distance visual acuities, suggesting the need to correct astigmatism of greater than 1D.[1]

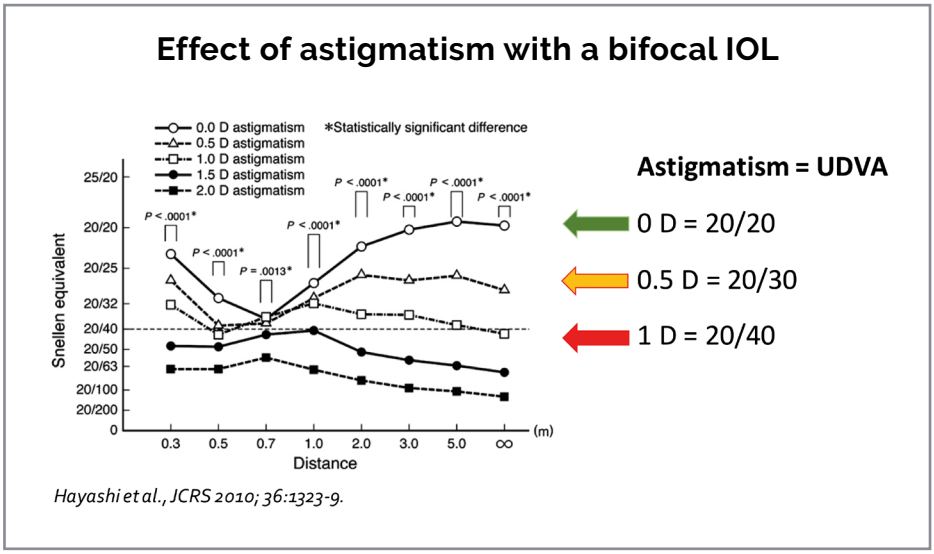

Figure 6: *With astigmatism simulation, visual acuity was compromised at all distances in eyes with a diffractive multifocal IOL*

RESIDUAL ASTIGMATISM

McNeely et al. looked at the impact of residual astigmatism with the Lentis 3D near add bifocal IOL and found that uncorrected distance visual acuity (UDVA) dropped as refractive astigmatism increased[2] – nearly one line difference between those patients who had less than 0.5D of astigmatism and those who had between 0.75D and 1.00D; a small difference but one that that has quite some impact. The study comprised 117 patients (234 eyes). There was a significant difference in UDVA, refractive sphere and defocus equivalent between the residual refractive astigmatism groups; however, there was no difference in quality of vision. McNeely found that the IOL appeared to subjectively tolerate residual astigmatism well, despite a statistically significant difference in UDVA with higher magnitudes of residual astigmatism, and noted that the angle of residual corneal astigmatism in relation to IOL placement did not have a significant impact on postoperative outcomes.

MULTIFOCALS AND ASTIGMATISM

Does it matter whether the multifocal lens in use is a bifocal, a trifocal or an EDOF lens? There is no good data yet, but the fact that there are different foci for each and a different intensity of light loss for each – higher for the classical bifocal lenses and less intense for the EDOF as well as the trifocal designs – suggests that the answer is yes, but the jury is still out.

In the absence of data to help direct us, what should we do to address these issues? First, be sceptical of your measurements, and repeat them every time. Also keep in mind that with respect to surgically-induced astigmatism, if we use small incisions such as 2.2mm or 2.4mm, we will induce little astigmatism. However, we also know that there is some variability; on average, there is very little induced astigmatism, but there are some outliers and these outliers can cause trouble.

> **A big difference between keratometry and topography measurements before surgery is a predictor of residual astigmatism**

Don't be satisfied with suboptimal outcomes. Aim for perfect optics, and be ready and willing to treat even small errors; and, as with any presbyopia-correcting device under-promise and over-deliver.

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Mitigating Postoperative Error in Refractive IOL Patients

By Sathish Srinivasan, MD

Patients who opt for a toric or a presbyopia-correcting intraocular lens (IOL) have high expectations. They expect emmetropia, and it is incumbent upon us to avoid unplanned postoperative refractive errors. The three categories of factors that should be considered when aiming to avoid postoperative refractive errors are preoperative factors, postoperative factors and intraoperative factors.

PATIENT SELECTION

The first and foremost preoperative factor that one needs to consider is patient selection. Patients you'll want to avoid if you are considering presbyopia-correcting IOLs include those who have ocular surface health issues and those who have anterior or posterior surface corneal problems. For instance, people who have epithelial basement membrane dystrophy or Fuchs' endothelial dystrophy are not ideal patients to consider.

The next issue to be aware of is irregular astigmatism – especially if you are working with either presbyopia-correcting IOLs or toric IOLs. These patients do well when they have regular corneal astigmatism compared to those who have irregular corneal astigmatism. Also, you'll want to avoid patients who have ectatic corneas, such as those with keratoconus or pellucid marginal degenerations.

Finally, the most important thing – which I see regularly in my practice – are patients who are contact lens wearers and have very unstable biometry. There is no magic number when to stop repeating biometries for these patients. Patients who wear hard contact lenses take longer to achieve a stable biometry because of contact lens warpage. The take-home message is patients who are wearing contact lenses need to have their measurements repeated. You need to repeat measurements until you attain at least two reproducible measurements. That's when you can be sure that what you're measuring is the true keratometric corneal readings.

QUALITY MEASUREMENTS

Accurate measurements and the quality of those measurements are also important preoperative factors to consider. It is very important to spend some time looking at the quality and standard deviations of the measurements. Most of the modern machines, such as the LENSTAR or the IOLMaster 700, are able to give you a standard deviation for each measurement so you can trust the quality of measurements that you get.

POSTERIOR CORNEAL ASTIGMATISM

Posterior corneal astigmatism is the second most important thing to consider with respect to factors that can contribute to postoperative refractive error. Due to Douglas Koch MD and others, we know that posterior corneal astigmatism has a negative power and can contribute anywhere from about 0.5D to 1.0D when you are measuring the total corneal astigmatism.

These measurements do have a great influence on IOL power calculations. The two ways of accounting for posterior corneal astigmatism are either to measure it with a Scheimpflug tomography system, or you can use one of several formulas that incorporate posterior corneal astigmatism even though you don't directly measure it.

For instance, the Barrett formula uses a mathematical regression analysis that factors in the posterior corneal astigmatism. There is also the Abulafia-Koch formula, which is another regression formula that takes into account the posterior corneal astigmatism when calculating IOL power. It's important to use these modern formulas not only for presbyopia-correcting IOLs, but even for monofocal IOLs so that you can more closely meet that emmetropic target.

The quality of the tear film is another variable that can be evaluated and optimised preoperatively to avoid postoperative error. If your patients have unstable tear film, poor tear film break-up time (TBUT) or a lot of corneal staining, this needs to be preoperatively treated.

Finally, make sure the patient's expectations match what you can deliver, the measurements are accurate, the capsulorrhexis is centred, the lens is stable inside the bag and the patient undergoes a timely postoperative examination to ensure stability of the IOL.

Amount of postoperative residual CYLINDER error in presbyopia IOL patients considered to be visually significant (i.e., likely to have an impact on visual quality and patient satisfaction)

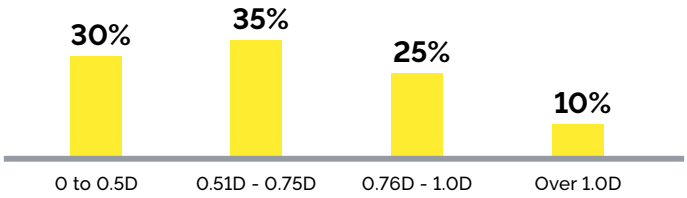

Figure 7: *Thirty-five percent of respondents to the 2017 ESCRS clinical survey do not believe that 0.75D of postoperative cylinder error is likely to have an impact on visual quality and patient satisfaction in presbyopia IOL patients*

> **The first and foremost preoperative factor that one needs to consider is patient selection**

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