KEYS TO SUCCESS
with LENS-BASED PRESBYOPIA & Astigmatism Correction

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Patient selection for presbyopia-correcting IOLs

Careful patient selection is key in obtaining optimal outcomes

By Béatrice Cochener, MD, PhD

With advances in intraocular lens (IOL) technology and surgical techniques, cataract surgery has evolved to become a refractive procedure for many patients.

Patient selection and patient education are important to achieve optimum results from premium IOLs. Patients have high expectations, especially if they are paying out of pocket.

Patient selection

When selecting suitable candidates, we need to assess patients’ motivation and visual needs and ensure that they have reasonable expectations.

It is essential to rule out progressive ocular diseases, such as glaucoma or maculopathy, as well as moderate-to-severe amblyopia, strabismus and abnormal binocular vision. In addition, the cornea needs to be perfectly transparent. Progressive systemic diseases such as diabetes or autoimmune diseases are contraindications for multifocal IOLs.

We need to obtain information on their family history of keratoconus, age-related macular degeneration and glaucoma and consider the long-term risk factors.

It is important to keep in mind that patients younger than 55 years have a higher risk of retinal complications and a higher level of expectations.

The keys to success are comprehensive patient information and rigorous patient selection

Preoperative assessment

Key evaluation parameters include visual acuity at distance, intermediate and near, considering monocular and binocular vision.

Cycloplegic refraction is necessary for patients of all ages, and we need to measure manifest refraction (best-corrected visual acuity). In cases with high ametropia, we need to take great care. We need to determine eye dominance, especially in monovision candidates.

To obtain optimum results from premium IOLs, a healthy ocular surface is essential. During this assessment, we ask patients about their symptoms and perform a slit-lamp examination, lid examination, Schirmer’s and dye testing, including quantification of tear breakup time. Newer technologies are shown in Figure 1.

For advanced IOLs, we need to use videotopography and biometry with interferometry. The overall tendency when performing IOL calculations is to target emmetropia for multifocal IOLs and possibly micromonovision with extended depth of focus IOLs.

Patients need to understand they will not achieve the vision they had when they were in their 20s, vision depends on light conditions, neuroadaptation will take two weeks to three months and night vision will be impacted. They also need to be aware of expenses associated with the procedure.

Conclusion

Presbyopia-correcting IOL procedures are more predictable, with faster visual recovery, compared with the corneal approach. We can compensate for loss of accommodation combined with correcting low-to-moderate ametropia, and these procedures should be preferentially indicated when the crystalline lens is ageing. The keys to success are comprehensive patient information and rigorous patient selection.

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Managing astigmatism in presbyopic patients

More precise measurements are necessary to manage astigmatism

By Thomas Kohnen, MD

Today’s patients seek clear near, intermediate and distance vision from presbyopia-correcting intraocular lenses (IOLs).

The following pearls will help surgeons achieve optimum results by managing astigmatism:

1. Understand astigmatism

Compared with anterior corneal astigmatism, refractive astigmatism in most eyes has less net plus power along the vertical meridian, so it has less with-the-rule or more against-the-rule astigmatism.

2. Examine at least three data points

We use the autokeratometer to measure power, tomography or topography for alignment and patients’ glasses to determine whether astigmatism is with or against the rule. If a discrepancy occurs between the first two, we need to repeat measurements.

We can examine the posterior surface, which increases the net power of the astigmatism, and sources of error include the crystalline lens, posterior cornea and retina.

We look at the corneal power in terms of tangential, sagittal and total corneal refractive power maps.

3. Recognise that we are not as good as we think

Measurements taken one week apart may differ. When we examined the repeatability of astigmatism measurements of five devices, the Scheimpflug had the most precise measurements.

4. Factor in posterior corneal astigmatism

Posterior corneal astigmatism contributes to against-the-rule refractive astigmatism. Research has shown that the posterior surface contributes 0.3D to total corneal astigmatism.

5. Determine total corneal refractive power

We need to consider the entire cornea. The map in Figure 2 uses ray tracing to calculate the total corneal refractive power. Parallel light is sent to the cornea, and light beams are refracted according to the correct refractive index, slope of the surfaces and exact location of the refraction.

6. Consider drift with age

When determining the target, small amounts of with-the-rule astigmatism should be maintained to account for the against-the-rule shifting with age.

7. Determine toricity

IOL power and anterior chamber depth (ACD) determine effective toricity. The IOL formula should consider posterior corneal astigmatism and the effect of IOL power and ACD on effective IOL toricity.

8. Calculate your results

It is important for surgeons to optimise their own lens constants and calculate their surgically induced astigmatism.

9. Understand the effect of astigmatism on multifocal IOLs

Hayashi et al. reported that, with multifocal IOLs, visual acuity degrades as astigmatism increases.

Conclusion

Astigmatism management is very important, particularly in patients with presbyopia-correcting IOLs.

References


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Extended depth of focus (EDOF) intraocular lenses (IOLs) were introduced recently to correct presbyopia. EDOFs provide an extended range of vision rather than distinct foci, with very good distance and intermediate visual acuity. In addition, we can adjust the refractive target to improve near vision. EDOFs also maintain binocular summation.

EDOFs cause fewer night vision problems than multifocal IOLs, and they are more forgiving of residual error compared with multifocal IOLs. However, near vision is not as sharp.

Assessing the efficacy of EDOFs
Surgeons can measure the efficacy of EDOFs through near and intermediate visual acuity, a defocus curve (subjectively) or a focus scan or defocus curve (objectively).

EDOF IOL approaches vary, as shown in Figure 3.

The Tecnis Symfony (Johnson & Johnson Vision) has an achromatic diffractive optical design created to deliver an elongated focus. It corrects chromatic aberration to increase contrast sensitivity, and the HARMONY and CONCERTO trials showed that it provided good depth of focus for all distances, with a low incidence of halo and glare.1,2

The AT LARA 829 (ZEISS) has a diffractive optical design, and it is aberration neutral. It has two power additions to create an optical bridge effect. This EDOF uses Smooth Micro-Phase technology to optimise optics and minimise light scattering and glare. Results for visual side-effects were favourable in preclinical testing.

The Lentis Comfort (Oculentis) is an aberration-correction lens with a near add with enhanced depth of focus, and InstantFocus (Swiss Advanced Vision) has a hybrid refractive (near and intermediate vision) and diffractive (distance vision) aspheric design. The Precizon Aspheric Presbyopic IOL (Ophtec) has a hybrid refractive aberration-neutral design. The IC-8 (AcuFocus), which is implanted in the nondominant eye, has a small aperture.3 The Mini Well Ready (Sifi Medtech) has three optical concentric zones and a continuum of foci, and the Bioanalogic WIOL-CF (Medicem) expands after it is implanted and has an infinite number of focal points.

Patient selection
The ideal EDOF patient seeks functional vision for most daily tasks, accepts limitations and has minimal astigmatism unless a toric EDOF or small-aperture IOL is being used. However, I recommend avoiding patients who demand very sharp uncorrected near vision, those who read a lot and those who expect to be completely spectacle independent.

EDOFs are an easy solution for presbyopia because they are forgiving

Conclusion
EDOFs are an easy solution for presbyopia because they are forgiving. They have a low incidence of optical phenomena, so they provide a reasonable compromise with a high degree of satisfaction.

References
2. DOF2016CT0030_Symfony Harmony EMEA Trial 3-Month Final Results.

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Understanding bifocal and trifocal IOL options
Multifocal IOLs provide advantages for those seeking spectacle independence

By Roberto Bellucci, MD

Two types of multifocal intraocular lenses (IOLs) are available – refractive and diffractive multifocal IOLs.

Refractive multifocal IOLs have zones refracting distance vision with the base power and near vision with the near add. Because concentric multifocal IOLs provide good distance and intermediate vision but near vision is not as sharp, we have the different concept of zonal refractive multifocality. This design reduces the incidence of halos by 50%, but coma may develop with large pupils.

Diffractive multifocal IOLs are based on the undulatory nature of light, with selective dephasing of light waves in order to produce two or more foci. They are reported to produce good distance and near vision, with intermediate vision depending on the near add in bifocals, but they are associated with some visual and optical disturbances.

We have a wide range of diffractive multifocal IOLs, including hydrophilic acrylic and hydrophobic acrylic, as well as those offering different light distribution, different dioptic adds and mixed and complex optics.

Seamless vision
Striving for seamless vision, designers introduced a new option because bifocal IOLs may not be ideal for intermediate vision. Taking advantage of harmonic foci, mixing two lenses for a trifocal lens (e.g., one with a 1.75D intermediate value and the other with 3.5D), it better uses the incident and transmitted light. Trifocal IOLs produce better intermediate vision than bifocal IOLs, with consistent clinical outcomes for visual acuity and contrast sensitivity (Figure 4).

Although advances have improved quality of vision, we need to exercise caution if patients expect perfect, sharp vision

The latest development is a quadrifocal IOL with three active foci to provide intermediate vision that is closer to the near vision as compared with trifocal IOLs. The initial results are encouraging. However, it appears night vision problems and dysphotopsia have not been overcome.

With different dioptic powers, halos will develop, and with diffraction rings, starbursts occur. These are the current trade-offs of multifocality.

We also have add-on sulcus multifocal IOLs designed for patients with pseudophakic eyes who seek greater spectacle independence. My experience has been very good with these lenses.

Patient selection
The key question to ask patients is whether they would like to be free of spectacles. If they would, are they willing to accept minor optical disadvantages and the additional cost?

It is important to choose the lens technology that fits a patient’s professional and leisure visual needs.

Conclusion
Multifocal IOLs can be a useful tool for presbyopia correction. Although advances have improved quality of vision, we need to exercise caution if patients expect perfect, sharp vision.

Dr Bellucci is former chief ophthalmic surgeon, University Hospital, Verona, Italy. He can be reached at robbell@tin.it He has financial interests in Bausch + Lomb, PhysIOL, SIFI, VSY and Hanita Lenses.
Keys to Success with Lens-Based Presbyopia and Astigmatism Correction

A number of presbyopic intraocular lens (IOL) procedures are available to help patients achieve visual flexibility, but we do not have a universal solution. Therefore, it is important to personalise our treatment plans for each patient.

Monovision relies on intraocular suppression of blur, but there are trade-offs. Increasing anisometropia improves near vision but worsens stereopsis. Figure 5 shows the advantages and disadvantages of monovision. Monovision is evolving toward mini- and micro-monovision.

Patient selection

Monovision works best in patients with weak-to-moderate ocular dominance because they have better intraocular suppression. Patients can try a contact lens trial to experiment with monovision for real-world tasks, and this helps us determine the preferred eye for each distance. However, this is difficult when cataracts are present.

Conventional and crossed monovision can provide good results, but conventional mini-monovision is more popular.\(^1\) We can have modified monovision with monocular-induced spherical aberration to increase depth of focus. In those cases, we target emmetropia to correct spherical aberrations in the distance eye and in the near eye we do not correct or induce spherical aberration.

In addition, we can combine mini-monovision with extended depth of focus (EDOF) IOLs. They are more tolerant to residual error than multifocal IOLs. The three EDOFs we have used have offered better intermediate vision compared with trifocal IOLs.

In the dominant eye, we can target emmetropia with an EDOF IOL, evaluate the first week after surgery, and if the patient has a good functional status and is pleased, we can use the same IOL target for emmetropia in the second eye.

If the patient needs more near vision, we can use the same IOL but target micro-monovision. In most cases, it takes only approximately 0.5D to provide a full range of vision. If the patient requires more near vision and does not want to compromise distance vision, we can implant a bifocal IOL.

Conclusion

We are fortunate to have many presbyopia-correction solutions. Monovision may be good for select patients. EDOF IOLs are suitable for micro-monovision and to mix and match, and new presbyopia-correcting IOL designs will emerge in the future.

Reference


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### Monovision

<table>
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<tr>
<th>PROs</th>
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<tr>
<td>• Cost-effective</td>
<td>• Loss of stereopsis</td>
</tr>
<tr>
<td>• Good monocular quality of vision</td>
<td>• Loss of binocular summation</td>
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<tr>
<td>• Less sensitivity to decenteration</td>
<td>• Risk of asthenopia</td>
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<tr>
<td>• Less sensitivity to capsular opacification/contraction</td>
<td>• Limited intermediate vision</td>
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<td>• Better solution if patient develops macular disease or other conditions that reduce contrast sensitivity (CS)</td>
<td>• Need spectacles for night driving and prolonged reading</td>
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Figure 5. Pros and cons of monovision
Preoperative tools and diagnostics: improved treatment planning for toric IOLs

New technology enables more precise preoperative measurements

By Adi Abulafia, MD

To achieve optimal refractive results from toric intraocular lenses (IOLs), our preoperative measurements must be as precise as possible. New technology can help surgeons achieve this goal.

Diagnostic technology

Industry has recently introduced promising new biometry devices designed to improve accuracy, ease of use and the ability to perform measurements through dense cataracts. These devices mainly fall into two categories: those that apply Scheimpflug technology combined with partial coherence interferometry (PCI) and swept source optical coherence tomography-based devices (SS-OCT). Most are calibrated to maintain the ULIB constants, so we can keep our own constants.

In general, SS-OCT-based devices have an overall higher success rate in measuring the axial length as compared with optical low-coherence reflectometry and PCI devices.1,2

For accurate results, we need to validate our measurements. Some new devices offer access to raw data so we can determine the quality of our measurements, and some integrate new IOL power calculation formulas.

Assessing astigmatism

Before determining the corneal astigmatic power and meridian, we need to be sure the astigmatism is regular and symmetrical. The methodology described by Warren Hill, MD (https://www.doctor-hill.com) is recommended, utilising primary and secondary supporting instruments to validate the steep meridian and power difference between meridians.

In 2012, Koch et al. reported the importance of posterior corneal astigmatism in toric IOL calculations and that standard keratometry and topography devices tend to yield inaccurate results in assessing the net corneal astigmatic power.3 Using a dual Scheimpflug device, they determined that most posterior corneas are steep vertically, creating a net plus power along the horizontal meridian, inducing against-the-rule astigmatism. In general, it reduces the net corneal astigmatism in with-the-rule eyes and increases it in against-the-rule eyes. Therefore, they published the Baylor nomogram as a first step to address the posterior corneal astigmatism effect.4 Today, there are several options to calculate or measure the total corneal astigmatism, which include several mathematical models and direct measurements of the posterior cornea (Figure 6).

In one of our studies, we evaluated the accuracy of direct measurements of the posterior cornea by a Scheimpflug-based device and found that the Barrett toric calculator was more accurate.5 However, new technology (e.g., SS-OCT based devices) appears promising. Another technology that is emerging is measurement of the second Purkinje image with reflection.

Conclusion

New biometry devices are more accurate and robust and are teasing us with the possibility of accurately measuring the posterior cornea.

New biometry devices are more accurate and robust and are teasing us with the possibility of accurately measuring the posterior cornea. Meanwhile, for toric IOL calculation, I recommend the use of mathematical models until we can accurately measure the posterior cornea.

References


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Intraoperative surgical alignment: technologies and techniques to navigate to your best outcomes
Selection of marking techniques is critical to success with toric IOLs
By Rudy M.M.A. Nuijts, MD, PhD

Toric intraocular lenses (IOLs) reduce astigmatism and improve uncorrected visual acuity, but some residual astigmatism may remain. Marking and IOL misalignment may lead to residual astigmatism; therefore, accurate marking and placement are critical to prevent misalignment.

Marking and IOL misalignment may lead to residual astigmatism

Comparing marking techniques
To manually mark the eye, I use a bubble marker. During surgery, I use a bimanual technique with a Mendez ring and a toric marker with sharp extensions.

Other manual marking systems include a pendulum marker and tonometer.

In a randomised clinical trial, we analysed three steps in the manual marking process — reference axis marking, alignment axis marking and IOL alignment. The mean misalignment was 2.4, 3.3 and 2.6 degrees, with a mean total error of approximately 5 degrees.

Popp et al. compared four manual marking techniques; the pendulum and slit-lamp markers performed better than the others. However, results vary between studies using the same technologies.

The digital marker system combines digital information from blood vessels, iris marks and keratometry values, enabling the surgeon to create a surgical plan that is integrated into the surgical microscope.

We found there was significantly less misalignment with digital marking vs. manual marking one hour after surgery, but it did not improve uncorrected distance visual acuity or residual astigmatism.

It is important to note that results for similar devices vary between studies (Figure 7). Intraoperative aberrometry provides streaming information during surgery on the magnitude and direction of cylinder. The surgeon can compare measurements with preoperative values and receive guidance in rotating the lens to reduce astigmatism.

Woodcock et al. reported that 89.2% of eyes for which intraoperative aberrometry was used had residual astigmatism of 0.5D or less vs. 76.6% in the manual marking group. Uncorrected vision did not differ between groups.

Conclusion
Mean errors with manual marking vary between approximately 2 and 5 degrees in most series. Digital marking can decrease misalignment by 50%, but it does not lead to better uncorrected vision. Significant variability occurred between studies using the same devices.

References

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Computer-assisted technology:
In two studies less residual astigmatism and less misalignment Results for similar devices between studies may vary significantly (eg. ORA)

Figure 7. Residual astigmatism and misalignment with digital vs. manual marking

* Indicates significant difference
Managing postoperative errors: pearls for success

When patients have suboptimal results after implantation of a toric intraocular lens (IOL), it is important to know how to manage postoperative errors to achieve satisfying outcomes.

Pinpointing the cause

Postoperative errors may result from improper IOL alignment or selection or from implantation in the wrong eye.

The IOL may be misaligned if we do not calculate surgically induced astigmatism accurately, factor in the posterior corneal astigmatism or place the IOL in the correct position or if the IOL rotates after surgery.

We may implant the wrong IOL if measurements or calculations are not accurate, surgically induced astigmatism was not factored in properly, posterior Ks were not included or transcription errors occurred during the online calculation of the IOL.

Errors also may occur if the patient is not a good candidate for the IOL, such as someone with ocular surface disease, epithelial basement membrane dystrophy, corneal ectasia or irregular astigmatism.

If a patient is dissatisfied with his or her surgical outcome, we begin by searching for the source of error.

Correction strategies

If a patient is dissatisfied with his or her surgical outcome, we begin by searching for the source of error. We use several devices to confirm that measurements of magnitude and direction are consistent. We ensure that the posterior cornea was factored in and that we used the correct lens. When performing a slit-lamp examination, we dilate patients’ pupils to determine that the meridian and axis match the desired location.

Figure 8 shows a case in which a toric IOL rotated almost 40 degrees postoperatively, impacting the patient’s uncorrected distance vision. It is important to keep in mind that the amount of misalignment and absolute loss of toricity depend on the toricity of the IOL. The higher the toricity, the more sensitive the IOL is to misalignment.

Using the toric analyser by John Berdahl MD and David Hardten MD (astigmatismfix.com), the ASSORT program (www.assort.com) by Noel Alpins MD or the Barrett Toric Calculator (http://www.ascrs.org/barrett-toric-calculator) will help us determine whether it is worthwhile to rotate the IOL or if we need to perform a lens exchange or laser vision correction.

We need to discuss our findings with the patient and plan a course of action. When performing a rotation, it is important to perform it early to reduce the risk of complications.

Conclusion

To obtain optimal results from toric IOLs, we need to select the right patient, perform meticulous calculations and use the latest technology. It is also important to use precise surgical techniques and perform timely dilated postoperative examinations to detect misalignments early and treat them as soon as possible.

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