

CORRECTING ASTIGMATISM IN THE PSEUDOPHAKA

SIX SURGEONS DISCUSS THEIR
PREFERRED METHOD OF CORRECTION
AND THE REASONING BEHIND THEIR
PREFERENCE.

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BY GERD U. AUFFARTH, MD, FEBO

Supplementary Sulcus-Fixated Toric IOLs

There are many patients for whom and situations in which the correction of astigmatism is important. In the event of residual astigmatism in a pseudophakic patient, in addition to corneal incision techniques, laser treatments, and capsular bag-fixated

toric IOLs, the implantation of a sulcus-fixated add-on toric IOL is a helpful option for correcting astigmatism. In Germany, toric add-on IOLs have been available as customized implants since the end of the 1990s.¹⁻³

A fundamental difference between supplementary sulcus-fixated toric IOLs and other toric IOL correction methods is the fact that the calculation of the additional toric IOL power is based on the subjective refraction. The manifest refraction must be stable and reproducible after repeated testing (two to three times).

The prerequisite for the implantation of a toric add-on lens is the presence of a capsular bag-fixated IOL that already corrects the patient's aphakia. The add-on lens then usually contains only the pure cylinder value, sometimes with a residual refraction if spherical correction is also needed.

SOURCES OF RESIDUAL ASTIGMATISM

By Mitchell P. Weikert, MD

If a patient presents with residual astigmatism following cataract surgery, the first step is to determine the cause of the residual astigmatism. The three most common sources of error are inaccurate preoperative biometry, suboptimal IOL choice, and lens misalignment.

Inaccurate preoperative biometry. The preoperative biometry must be reviewed to ensure that the quality of the measurement was not compromised. Biometry is then repeated postoperatively to determine if there is remaining astigmatism and where it is located. I also look for any signs of corneal irregularities, such as ocular surface disease or epithelial basement membrane dystrophy.

Suboptimal IOL choice. If the astigmatism was over- or undercorrected, this could indicate that the IOL choice was not adequate. If an IOL exchange is warranted, revisit how

the original toric IOL was chosen, determine whether the astigmatism was with-the-rule or against-the-rule preoperatively, and reassess the posterior corneal astigmatism.

One important consideration in toric IOL exchange is that the higher the overall lens power, the greater the effect of the toric correction.

Lens misalignment. The lines on the toric IOL itself should be used to help gauge lens alignment and determine how to rotate the lens into the correct position. Consider which method of marking was used such as manual marking, intraoperative aberrometry, or an automated system such as the Callisto eye (Carl Zeiss Meditec) or the Verion Image Guided System (Alcon) and adapt accordingly when you rotate or exchange the IOL. Finally, consider whether there is something about the patient's eye that put him or her at risk for rotation of the IOL postoperatively, such as a large capsule.

INDICATIONS

The indications for this method of astigmatism correction are broad and include those in the following list.

► **Astigmatism correction years after initial cataract surgery.** This is a particularly interesting indication if the patient wants to be free of glasses, at least for distance.³ Not infrequently, a low toric correction in the range of just under 1.00 D is required if, for example, a premium IOL is causing problems due to surgically induced astigmatism. Instead of correcting this astigmatism

with corneal laser vision correction touch-up, an add-on IOL can be used successfully because it does not cause any further aberrations.

► **Refractive surprise.** The use of toric add-on IOLs for refractive surprises is a simple method to eliminate astigmatism in pseudophakic patients. The implantation of a toric or spherical sulcus-fixated add-on IOL is easy and can be performed under topical anesthesia. It requires dilating the pupil and opening the ciliary sulcus using an OVD. The add-on IOL is then inserted into the sulcus and aligned with the axis position. The OVD can then be removed and lens alignment can be fine-tuned.

► **Correcting high astigmatism.** Another indication for supplementary add-on IOLs is in the correction of high astigmatism such as that present after penetrating keratoplasty.^{1,2} Companies such as 1stQ, Rayner, and

HumanOptics produce customized toric IOLs that can correct high degrees of astigmatism—between 10.00 D and 20.00 D; however, it should be noted that these lenses may not be available in the United States.²

It also should be noted that rotational stability varies among the IOLs from these different companies. Supplementary toric IOLs with four-point fixation, such as the AddOn IOL (1stQ), are more stable than IOLs with a C-loop haptic design.

ADAPTABILITY BENEFIT

In patients who require penetrating keratoplasty a second time and who already have a toric add-on IOL, the toric add-on IOL can be easily exchanged. The ability to make changes if needed is one general advantage of sulcus-fixated add-on IOLs. When changes occur over a longer period of time—such as when surgery is carried out in a young patient for a juvenile cataract with

astigmatism or a traumatic cataract with astigmatism—the add-on toric IOL can be removed or replaced, even if those changes take place over a period of 10 to 20 years.

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BY JOHN P. BERDAHL, MD

Toric IOL Rotation

Toric IOL rotation is my go-to method for correcting astigmatism in the pseudophake because many variables can be removed from the IOL power calculation equation. After cataract surgery, the astigmatism refraction is simply the vector sum of the total corneal astigmatism and the total lens astigmatism.

One of the challenges in correcting astigmatism is that the healing of the eye is unpredictable. Surgically induced astigmatism can be surprising after cataract surgery, and many of us don't measure posterior corneal astigmatism preoperatively. When we rotate a toric IOL after cataract surgery to correct a residual error, those aspects of IOL calculation no longer have to be considered because they are already accounted for in the manifest refraction.

Because we already know the position and power of the toric IOL, the ideal location of the IOL inside the eye can be accurately predicted. With the help of free websites such as the Toric Results Analyzer, the vector calculations can be easily performed for the surgeon. Once the calculations are in hand, the surgeon must simply take the patient back to the OR, mark where the IOL is currently located, mark how much rotation is necessary to minimize the astigmatism, and rotate the IOL into the new position.

Laser vision correction is an option to correct residual error, but it comes with the downside of healing concerns. Many surgeons prefer to perform PRK for this type of correction, but PRK in older patients can be a challenge because the epithelium can be irregularly thickened.

That irregular epithelium can lead to a manifest refraction that is different preoperatively from what it would be postoperatively. My experience has been that, for these reasons, PRK enhancements are unreliable in older patients. Further, not all surgeons have access to an excimer laser to perform laser vision correction for a residual refractive error.

Toric IOL rotation, on the other hand, is fairly straightforward, and it's a procedure that all cataract surgeons can do and have the equipment to do.

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PRK

Residual astigmatism after cataract surgery is a frustrating situation, especially for patients who are trying to gain some level of spectacle independence. Even when the cataract surgeon has done something to correct astigmatism at the time of surgery—whether it be limbal relaxing incisions, astigmatic keratotomy, implanting a toric IOL, or even implanting the Light Adjustable Lens (RxSight) with all of the adjustments it allows—some patients will still have residual astigmatism and will desire better uncorrected vision.

In my opinion, each of the methods for correcting residual astigmatism in the pseudophake serves a unique purpose. However, I use PRK for residual astigmatism in the great majority of patients who require this type of enhancement. This is because most of these enhancements are for small levels of residual astigmatism, typically less than 1.00 D, and they are also associated with a small amount of myopia or hyperopia. With PRK, I can address both of these types of refractive error.

OTHER OPTIONS

LASIK is not my preferred option for correcting astigmatism in patients with basement membrane dystrophy, which includes many of the older patients I see. In these patients, there is a higher

risk of an epithelial defect or epithelial ingrowth after LASIK.¹

Toric IOL rotation is an option when the rotation will correct the astigmatism and the spherical equivalent is on target. Often, however, the patient has residual spherical refractive error along with the residual astigmatism, and this eliminates toric IOL rotation as an enhancement option. Additionally, in some patients, it is difficult to determine exactly the orientation to which the IOL should be rotated.

WHY PRK?

PRK, especially for low levels of astigmatism, has a fairly rapid recovery time, often around 1 month for the patient to achieve reasonably good vision. Recovery times are longer, however, if the patient has had previous laser vision correction. Of course, the epithelial defect takes time to heal, and the patient's vision may not be great during the first few weeks after the procedure.

Before considering PRK for the correction of astigmatism in the pseudophake, the clinician should take a careful look at the posterior capsule. If striae or a small amount of haze is present, it may be wise to consider opening the capsule before performing the PRK enhancement.

Doing this will allow refraction and wavefront aberrometry to yield higher-quality refractive information. Additionally, simply opening the posterior capsule in a patient who has some haze or striae may reduce the symptoms associated with any residual astigmatism. Once the posterior capsular opacity is removed, it is no longer causing light scatter, leading to overall higher-quality vision.

CONCLUSION

I'm a big advocate for having PRK in the toolbox for management of most of the residual refractive errors I see after IOL implantation. There are occasional uses for the other modalities, but PRK is my go-to procedure for that last polishing touch.

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BY EDWARD E. MANCHE, MD

LASIK

My colleague Christopher S. Sáles, MD, MPH, and I conducted a review of keratorefractive and intraocular approaches to managing residual astigmatic and spherical refractive error after cataract surgery, including LASIK,

PRK, arcuate keratotomy, IOL exchange, piggyback IOL, and light-adjustable IOL.¹ We found that, among the methods being discussed by the surgeons in this article, the most accurate method of correcting residual refractive error

and astigmatism is a keratorefractive approach—either LASIK or PRK.

When a patient's eye is amenable to both LASIK and PRK, I prefer LASIK. This article lays out the reasons for that preference.

WHY LASIK OVER PRK?

Patients who have residual refractive error after cataract surgery tend to be significantly older than patients who undergo PRK or LASIK as a primary surgery. Due to the older age of this cohort, patients are more likely to have systemic conditions such as diabetes and may have anatomic issues such as lid laxity that can adversely impact corneal wound healing.

Therefore, the outcomes in this patient population may not be as good as would be seen in a young eye that has never undergone surgery. The visual acuity recovery time after LASIK is much faster than the recovery time after PRK. The typical recovery period after PRK is several weeks, and in many cases, it can take several months to achieve the end result. This is especially true if there are issues with reepithelialization of the cornea.

Patients who undergo LASIK, on the other hand, can expect their vision

to recover quickly; they typically have excellent vision with little or no discomfort by postoperative day 1. In LASIK, there is minimal wound-healing response compared with PRK. Patients who undergo LASIK are able to see well, for the most part, by the next day after the procedure, and can therefore resume normal activities right away. With PRK, the patient ends up having 2 to 3 days of mild to moderate pain and a prolonged visual recovery.

The prolonged visual recovery after PRK can be especially problematic if, for example, the patient has a visually significant cataract in his or her other eye. This patient would have poor binocular vision due to the remaining cataract in one eye and the transient blurriness during the early postoperative period in the other eye. This can interfere with the patient's activities of daily living for many days and weeks.

CONCLUSION

The accuracy and predictability of targeting residual refractive error—both sphere and astigmatism—is significantly better using a keratorefractive approach than with IOL exchange or limbal relaxing incisions. As outlined here, there are a variety of benefits in choosing LASIK over PRK.

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BY MITCHELL P. WEIKERT, MD

IOL Exchange

Regardless of the method chosen to correct residual astigmatism, it is important to first identify the source of the error (see “Sources of Residual Astigmatism,” pg 34). When IOL rotation will not produce the desired refractive outcome, IOL exchange is the best option and my preferred method of correcting astigmatism in the pseudophake. It is typically easiest to perform within the first few weeks after the original surgery.

IOL exchange is a go-to for me if the patient's overall refractive error is myopic or hyperopic and not close to plano, if the rotation of the IOL was significant, if the patient is not a good candidate for either LASIK or PRK or corneal relaxing incisions, and if a change to the overall spherical equivalent is required, as

this cannot typically be achieved with corneal relaxing incisions.

When one toric IOL is exchanged for another, the current position of the toric IOL can be used to guide placement of the new toric IOL. For example, if the current toric IOL was positioned at 90° and calculations indicate that the new lens would be best positioned at 110°, simply measuring 20° from the current position should achieve very accurate results.

COMPLICATING FACTORS

Factors that can complicate exchanging the IOL must be taken into consideration before selecting this approach to correcting residual astigmatism. These include:

- A small capsulorhexis with significant capsular fibrosis;
- A large capsulorhexis that extends beyond the optic;
- Fusion of the anterior and the posterior capsules; and
- A prior tear in the capsule.

IOL exchange is still possible in the presence of an anterior or posterior capsular tear; however, care must be taken not to extend the tear while removing the IOL from the capsule. Using tools that can increase accuracy during the IOL exchange are vital, especially if tools of this kind were not used during the original procedure.

CONCLUSION

In my opinion, IOL exchange is the

best option when rotation of the IOL will not produce the desired refractive outcome and if the patient is a poor candidate for LASIK, PRK, or corneal relaxing incisions. Ultimately, identifying the source of the error is helpful in determining the best approach to correction.

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Astigmatic Keratotomy

When we set prices for premium cataract surgery, we factor in the cost of surgical touch-ups for 1 year after the date of the patient's initial surgery. These surgical touch-ups can come in the form of LASIK, PRK, IOL exchange, IOL rotation, add-on IOL, or astigmatic keratotomy (AK).

Delivery of each of these surgical options involves a cost, but the most cost-effective of the options is AK. For low amounts of astigmatic correction, AK is an accurate and easy way to make a pseudophakic patient with residual astigmatism happy.

AK is an invaluable tool for the correction of astigmatism. In my practice, we explain astigmatism to patients using two items: a ping-pong ball and a spoon. We explain that the front window of the eye, the cornea, ideally should be perfectly round—like a ping-pong ball—a perfect sphere that has the same curvature in all directions. Astigmatism occurs when the cornea is not perfectly round and has a steeper and a flatter meridian, like the back of a spoon. Astigmatism causes distortion and blurring of image quality.

The goal of AK, we explain, is to reduce the astigmatism by making the cornea rounder or more spherical, less like the back of a spoon and more like the shape of a ping-pong ball. If the cornea can be made more spherical, then the patient will see better.

WHO IS A GOOD CANDIDATE?

Patients who have myopic astigmatism in which the spherical

equivalent will result in a favorable postoperative refraction are the ideal patients for AK. The procedure works on the principle of coupling—the reduction in astigmatism will result in a 50% reduction in the magnitude of the spherical component of the refraction.

HOW DOES AK WORK?

The astigmatic incision, placed on the steep axis of corneal curvature, causes a microscopic incision gape that in turn causes corneal flattening in that axis, thus reducing the astigmatism.

Preoperatively, a rock-solid refraction and corneal topography are required. The patient must be informed of the risks, benefits, and alternatives to AK and the likelihood of achieving a refractive outcome that he or she will be satisfied with.

Intraoperatively, AK takes about 3 minutes to perform and is painless. Three drops of proparacaine anesthetic are instilled in the eye, and then a mark is placed at the 3 and 9 o'clock positions of the cornea while the patient is sitting upright. The patient is then reclined and positioned under the operating microscope. An eyelid speculum is placed to keep the lids apart, and the patient is instructed to look straight ahead at a fixation light.

In my practice, we use an AK nomogram. For the average patient 65 to 75 years old, the diamond blade is preset to 600 μm depth. That diamond blade is applied using an 8-mm optical zone. Each 2-mm incision, or 30° of arc, produces 1.00 D of corneal flattening.

Two 2-mm incisions, one on each side, will produce 2.00 D of corneal flattening. For younger patients, I am more aggressive and use longer incisions; for older patients, I am less aggressive and make shorter incisions.

Postoperatively, I prescribe a combination antibiotic-steroid drop three times a day for 5 days. Patients return 1 week after their procedures for refractive assessment. Patients usually report a scratchy sensation or some stinging for at most 3 hours postoperatively. Virtually all patients should be able to resume normal activities the same day, and vision improves within 1 day for most patients.

CONCLUSION

For most patients, there's about a 90% chance that AK will achieve enough astigmatic reduction that the patient will be happy with his or her improved vision. For about 10% of patients, LASIK or PRK will be required to fine-tune the astigmatism correction.

The beauty of AK is that it is quick, safe, and cost-effective. The equipment needed is an operating microscope, diamond blade, caliper, axis marker, optical zone marker, 0.12-mm forceps with teeth, and eyelid speculum. We don't need a femtosecond or excimer laser, which entail much greater costs for the patient and surgeon. ■

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