It's a Toric World

Optimizing Cataract Surgery Outcomes with Toric IOL

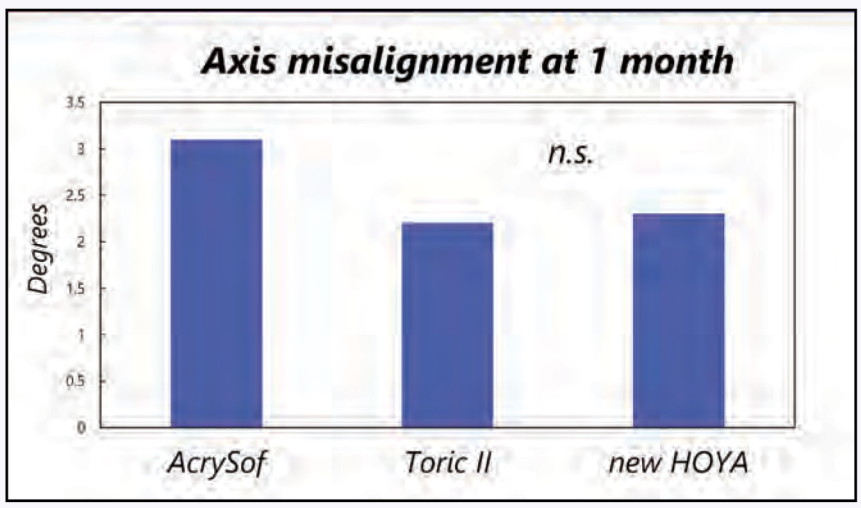
On Thursday May 20, 2021, APACRS hosted a webinar with four key leaders in refractive cataract surgery: Dr. Tetsuro Oshika (Japan), Dr. Graham Barrett (Australia), Dr. Ronald Yeoh (Singapore), and Dr. Hungwon Tchah (South Korea). Presentations were given by each of these key leaders followed by discussion. As toric intraoperative lenses (IOLs) become more technologically advanced, cataract surgeons can tend to their patients' greatest needs by incorporating toric IOLs into their practice to provide them with the best outcomes.

Tips to Optimize Outcomes of Toric IOLs

Dr. Tetsuro Oshika from the University of Tsukuba in Japan provided tips on optimizing patient outcomes of toric IOLs.

Tip #1: Distinguish, before surgery, between regular astigmatism and irregular astigmatism. It is extremely important to do so when considering toric IOLs because only regular astigmatism can be corrected with toric IOLs. To do so, Dr. Oshika recommends viewing a Fourier map which decomposes topography into 4 different components: spherical, regular astigmatism, asymmetry, and higher-order irregularity. The asymmetry and higher-order irregularity topographies are characterized as irregular astigmatism and cannot be corrected with toric lenses.

Tip #2: The K value as measured by keratometry is not equal to total corneal astigmatism. The K value is estimated based on the anterior corneal surface measurement alone, and the posterior corneal surface is not considered. Looking at just the anterior cornea surface, younger eyes tend to exhibit with-the-rule astigmatism and changes to against-the-rule astigmatism in older eyes. However, the posterior cornea surface exhibits primarily against-the-rule astigmatism (ATR) in eyes of all ages; there is no shifting pattern towards with-the-rule (WTR) astigmatism. Therefore, it is very important to use proper toric calculators, such as the Barrett formula, to avoid undercorrecting for ATR astigmgatism or overcorrecting for WTR astigmatism.



Compared to other toric IOLs on the market, the TECNIS® Toric II IOL performs significantly better than the AcrySof® Toric IQ IOL and similarly to the HOYA Toric IOL in terms of axis misalignment at 1 month postoperative.

Tip #3: Precise axis marking is important. Typically, the surgeon places a reference mark on the patient's eye before surgery and the axis mark during surgery. Incorrect marking can be a source of error in toric lens placement. Incorrect markings may show vertical deviation as a result of the upper eyelid covering the cornea. Incorrect markings may also be seen as laterally deviated or asymmetrically placed. Markings can be made either manually or digitally using devices such as VERION™, CALLISTO eye®, or the ORA System™. In one small comparative study Dr. Oshika conducted, eyes were either manually or digitally marked, and the results showed no significant difference in postoperative axis misalignment between the two methods. Thus, digital marking is useful due to simplicity, although manual marking still provides accurate marking.

Tip #4: Use the latest model of toric IOLs. Recent advances in technology have allowed for modified haptics. In the new J&J Vision TECNIS® Toric II IOL, the frosted haptic offers more surface texture and increased friction within the capsule. In another study conducted by Dr. Oshika, axis misalignment was compared between the TECNIS® Toric IOL, which maintains the standard polished haptics, and the TECNIS® Toric II IOL. The results showed that the amount of axis misalignment was significantly reduced in the Toric II IOL compared to the Toric IOL, this clearly indicates that the rotational stability is very much improved with the TECNIS Toric II IOL. Dr. Oshika also compared the unfolding speed of the Toric IOL to the Toric II IOL and found that the Toric II IOL exhibited a significantly shorter time for initial haptic movement, complete separation of the haptic from the optic, and unfolding of the lens to 11mm. With the TECNIS® Toric II IOL providing faster release of the haptics as well as increased friction with the capsule, rotational stability is improved. From the discussion, Dr. Oshika explained that the unfolding speed is faster for the Toric II IOL than the old Toric IOL because the the frosted haptic does not stick to the optic while in the cartridge during insertion.

Tip #5: Anterior capsule coverage is very important for the rotational stability of the toric lens. When comparing complete coverage of the continuous curvilinear capsulorhexis (CCC) edge to partial coverage, Dr. Oshika found that the amount of axis misalignment at 6 months post-operative was statistically significant with complete CCC edge coverage exhibiting lower axis misalignment than partial coverage. Secure fixation of the lens in the capsular bag contributes to greater rotational stability.

Tip #6: When necessary, perform repositioning surgery at one week or later postoperatively. What's important is the timing of repositioning surgery and the final outcome. A study conducted by Dr. Oshika found that if repositioning surgery is performed immediately after cataract surgery, there is a significantly higher degree of final misalignment and, in fact, some IOLs rotated subsequently after repositioning surgery to the same direction. Contrastingly, waiting for 7 days or longer after cataract surgery significantly decreased the degree of final misalignment of the IOL. Furthermore, Dr. Os-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Graham BARRETT
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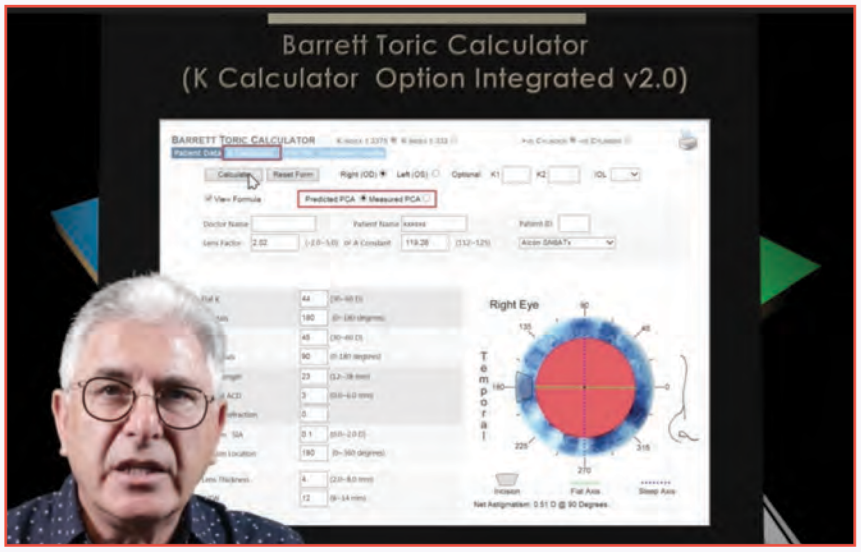
Ronald YEOH
Singapore


Hungwon TCHAH
South Korea



Dr. Graham Barrett discusses use of the Barrett Toric Calculator.

hika also found that the largest rotation of the IOL occurred from the end of cataract surgery to 1 hour after surgery. After 1 hour, the toric IOL stayed very stable. Dr. Oshika explained that waiting to perform repositioning surgery is effective because the capsule bag has not completely undergone fibrosis immediately after surgery, and the lens itself may stick to the capsule bag. Thus, the time period immediately after surgery is the most critical period for maintaining rotational stability of toric lens. Dr. Oshika's advice to reduce misalignment is to wait until the IOL has completely unfolded, stating that "some lenses are very slow to open, depending on the type of lens." He also advises surgeons to instruct patients to rest and avoid walking around for at least 1 hour after surgery. As for the following days and weeks after surgery, discussion from the panel agreed that high impact exercising, especially the up and down movement of jogging, should be avoided for 2-3 weeks.

Mastering the Barrett Toric Calculator

Dr. Graham Barrett of Australia presented "Mastering the Barrett Toric Calculator" and discussed the finer points of using the Barrett formulae. Toric IOLs play a key role in improving refractive outcomes and thus accurately predicting the required toric cylinder value is essential to the success of refractive cataract surgery. Improvements in technology have allowed new and more accurate formulae to be developed. One formula that is widely used is the **Barrett Universal II formula (BUII**), a vergence formula based on paraxial ray tracing. The BUII, available for use online on the APACRS website, calculates the principle planes for the predicted IOL and can be used with the measured posterior cornea. The BUII formula is identical to the Barrett TK formula that is available for use on the IOLMaster 700. The online calculator for the BUII formula allows a practitioner to enter data for both eyes as well as the lens model. Lens constants will be automatically entered, but one can also enter a specific lens factor or the A constant. Once calculated, a table will display IOL powers for the predicted spherical equivalent refraction.

Another formula to consider is the **Barrett Toric Calculator,** which is based on the BUII and provides the same spherical power prediction as well as the predicted toric cylinder value. The calculator predicts the posterior corneal power for each eye based on a theoretical model. Surgically induced astigmatism (SIA) should be listed as the centroid value, which is typically in the range of 0.1-0.12 for a 2.4 mm temporal incision. Dr. Barrett recommends a lens factor of 2.09, although a personal constant can be entered if preferred. The integrated K calculator and measured PCA options are quite valuable and are available after data has been entered and calculated. One important consideration is deriving a vector mean or median K, which is helpful in measuring corneal astigmatism for toric IOL calculations. This is because corneal astigmatism measurements are not always repeatable when using measures such as the Warren Hills validation criteria due to the poor correlation for the keratometric cylinder when measuring the axial length from different devices.

Dr. Barrett then explained the reason he developed the True K formula: to improve outcome prediction in eyes that have had previous refractive surgery. The **True K formula** has shown to be more accurate than other methods for patients who have undergone myopic LASIK when their refractive history is known and for patients who have undergone laser correction for hyperopia.

Dr. Barrett's True K TK formula, created last year, modified the True K formula and allows for the incorporation of the measured posterior cornea. Studies conducted by Dr. Barrett confirm that the True K with inclusion of the posterior cornea provided the most accurate and repeatable option in both myopic and hyperopic patients undertaking cataract surgery without prior refractive information.

Dr. Barrett also pointed out that there is a need for a custom toric calculator when selecting a Toric IOL in eyes that have undergone previous refractive surgery. After modifying the True K formula to create the True K TK formula, Dr. Barrett also updated the **True K Toric Calculator** which can now be used with the predicted posterior cornea or a measured option for posterior corneal astigmatism. Additionally, this True K Toric Calculator includes the K Calculator, allowing the user to enter up to 3 different values for the anterior cornea. The True K Toric Calculator will then calculate a new integrated K or median vector value which is used for the final calculation.

The last consideration for mastering Toric IOLs is learning how to manage unexpected outcomes in patients, whether by exchanging implanted lenses, adding a piggyback IOL, or rotating an existing Toric IOL. Formulas such as the Holladay R or Astigmatism Fix can provide solutions

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to spherical power and lens rotation. Dr. Barrett's **Barrett Rx** provides a solution for these scenarios in one single formula. Once implanted IOL power data, post-operative refraction data, and the lens constant are entered into the calculator, the Rx formula can provide the recommended spherical IOL, toric cylinder, and alignment required for an IOL exchange. Selecting the piggyback IOL option provides spherical power, toric power, and alignment values. Finally, the Rx formula displays a graph providing the rotation values for the existing lens to minimize residual astigmatism. The Rx formula is a comprehensive formula that provides all the required calculations to manage unexpected refractive outcomes in terms of IOL exchange, piggyback lens implantation, or Toric IOL rotation with both an IOL and effective lens position (ELP) option.

If a surgeon wishes to rotate the lens a week after the initial surgery, both Dr. Oshika and Dr. Barrett recommend using the online calculator to recalculate the axis alignment values since it provides an opportunity to get the patient's astigmatism as close to 0 as possible. "Precise postoperative refraction in these cases is key," says Dr. Barrett.

Clinical Tips and Pearls with Toric II

Dr. Ronald Yeoh offered his clinical tips and pearls for using the TECNIS® Toric II IOL in cataract surgery. The main challenges in achieving high toric lens implant rates in cataract surgery are inertia in adoption of new implants and variation in implantation technique. For toric IOLs, the usage around the world has been quite variable, from 50% in Australia to 10% in other countries. The main challenges of successful toric IOL use in cataract surgery involve the inertia of acclimating to this new technology and the implantation technique. These two challenges pose extra work for surgeons in learning how to implant IOLs as well as the supposed burden of placing the toric implant in the correct desired meridian. Additionally, surgeons may fear inaccurate refractive outcomes due to poor biometry. The most common fear, though, is malrotation of toric IOLs after implantation. With today's technology and the TECNIS® Toric II IOL, fear of malrotation is mitigated, providing surgeons with greater accuracy and improved patient outcomes.

In 2018, a comparison study done by Lee et al[1] showed that the AcrySof® Toric IQ IOL had a significantly lower mean rotation at 2.72 degrees postoperative compared with the old TECNIS® Toric IOL at 3.79 degrees. The old Tecnis® Toric implant had a higher repositioning rate. It was also noted that the malpositions were usually in an anti-clockwise position. With less than desired rotational stability, the TECNIS® Toric II IOL was created to improve this factor. After many redesigns, the simple solution of frosted haptics worked well enough to increase rotational stability.

In Dr. Yeoh's practice, he has had great success using the TECNIS® Toric II IOL with ease of implanting the IOL at the desired position as well as the ability to back-rotate lens if necessary. Dr. Yeoh provided useful tips for implanting any toric IOL while presenting three patient case videos of IOL insertion. Surgeons should make sure to inject the IOL and align the axis 10 degrees shy of the desired position, remove ophthalmic viscosurgical devices (OVDs) behind the IOL (to maintain stability of the lens), and then dial the IOL to the intended position. Whilst being careful to not over-rotate the IOL, surgeons should also press the IOL onto the posterior capsule using the side port. Dr. Yeoh finally advises patients to avoid sudden movements in the first hour after surgery and to avoid jogging and rubbing the eyes for 2 weeks after surgery.

Frosted haptics (right) in the TECNIS® Toric II IOL display a rough texture, designed to increase friction and rotational stability

Another advantage of the new TECNIS® Toric IOL is that the A constant is the same for all single piece Tecnis lens implants. Upon selecting the lens in the Barrett Toric Calculator, the lens factor and A-constant will automatically populate for the calculation. For Dr. Yeoh, he believes the TECNIS® Toric II IOL holds great promise, finding the lens "have stayed exactly where I've placed them and the outcomes have been very good."

Laser Cataract Surgery: Unmet Needs in Astigmatism Management for Cataract Patients

Dr. Hungwon Tchah discussed how unmet needs for astigmatism in cataract patients can be managed using a different approach: femtosecond laser-assisted surgery. Astigmatism, or the imperfection in the curvature of the eye's cornea or lens, results in blurry vision, eyestrain, headaches, and eye discomfort. After cataract surgery, uncorrected astigmatism significantly compromises a patient's vision, especially in the case of multifocal IOL insertion. Dr. Tchah offered a range of reasonable residual postoperative astigmatism values. For monofocal IOLs, astigmatism should range between less than 0.5 to 1.25 diopters (D), whereas bifocal IOLs require a tighter range between less than 0.5 to 0.75 D. Extended depth-of-focus (EDOF) IOLs allow for more tolerance than bifocal IOLs, while trifocal IOLs allow for less

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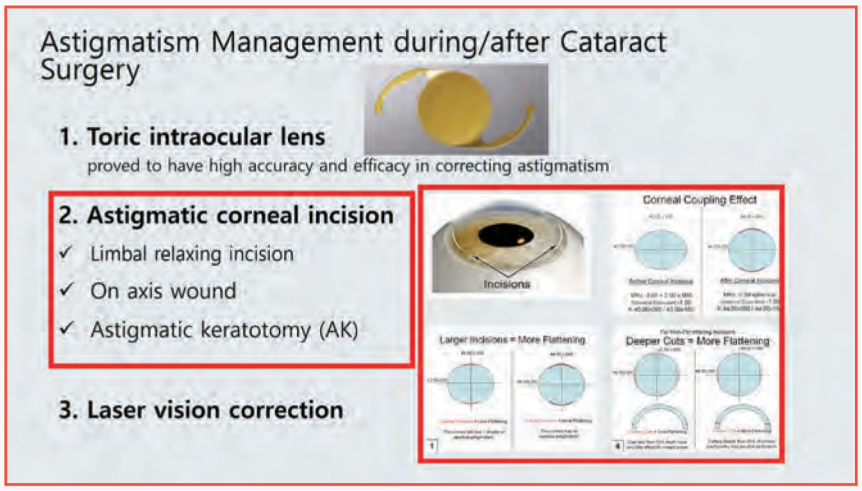
tolerance than bifocal IOLs. Dr. Tchah suggests maintaining residual postoperative astigmatism between less than 0.5 to 0.75 D, generally speaking.

In the Asian population, about 20-40% of patients with corneal astigmatism exhibit less than or equal to 0.5 D, and no treatment for astigmatism is recommended for these patients. Eight to 10% of the population experience astigmatism between 1.75 to 2.0 D, and this is when patients may benefit from toric IOLs. The majority of the patients, 50-70%, lie between 0.5 and 1.75 D. For this group of patients, it is not so clear as to whether the patient's astigmatism should be left untreated or treated using toric IOLs. Astigmatic incision may be more important than any other astigmatism management procedure as it is the most commonly performed procedure for astigmatic patients undergoing cataract surgery.

Limbal relaxing incision, on-axis incision, and astigmatic keratotomy (AK) are all categorized as astigmatic corneal incisions as they all exhibit the same principles for correcting for astigmatism. In the 1980s, Dr. Tchah published a paper outlining surgical approaches to mixed and myopic astigmatism. However, the problems Dr. Tchah faced were the lack of precision and reproducibility of the depth and length of the incision. Today, surgeons can perform femtosecond laser-assisted cataract surgery with greater precision for capsulotomy, nucleus fragmentation, astigmatic keratotomy, and wound incision. In a study by Roberts et al[2], femtolaser intrastromal AK was shown to



Astigmatic corneal incisions include limbal relaxing incisions (LRIs), on-axis wounds, and astigmatic keratotomy (AK). Femtolaser intrastromal AK has been shown to be more efficacious than LRIs and wound incisions and are more stable over the long

offer more efficacious, provided a more accurate correction of corneal astigmatism than limbal relaxing incisions, and can be more reproducible than manual AK. In his practice, Dr. Tchah personally prefers intrastromal femtolaser AK as it may provide a lower chance of infection, inflammation, and perforation as well as less postoperative patient discomfort. However, intrastromal AK may be less effective than toric IOLs for higher astigmatic eyes and require a longer arc incision despite being more stable over the long term.

Dr. Tchah conducted a study on the 1 year outcome of astigmatic correction after femtosecond laser-assisted phacoemulsification. Vector analysis showed a mean correction index of 0.77, meaning 77% of patients' astigmatism in the study was corrected. Postoperative corneal astigmatism at 1 year, compared with 3 months postoperative, showed better correction with 95% of patients exhibiting less than or equal to 1.0 D and 88% of patients exhibiting less than or equal to 0.75 D. A German study by Wendelstein et al[3] corroborated Dr. Tchah's findings showing that 100% of eyes treated with femtosecond laser-assisted corneal arcuate incisions shows less than or equal to 1.0 D and 97% of eyes showed less than or equal to 0.5 D of residual astigmatism. Wortz et al[4] found similar results using the same procedure at 4 weeks after surgery with 100% of patients experiencing less than or equal to 1 D. These studies provide evidence that femtosecond laser-assisted AK does indeed provide good results in terms of managing astigmatism in cataract patients.

In Dr. Tchah's routine surgery practice, he performs only femtosecond laser-assisted AK procedures except in cases where patients require toric IOLs and cases with < 0.5 D. Although Dr. Barrett finds keratometry incisions to be unpredictable in terms of the error in predicted astigmatism, Dr. Tchah's experience has shown that the error is indeed negligible for patients with low to moderate astigmatism. For this reason, Dr. Tchah will turn to toric IOLs when a patient exhibits > 2.0 D. Additionally, Dr. Tchah states that all intrastromal AK procedures result in less side effects than when performing transepithelial AK. Additionally, Dr. Tchah also uses a manual axis marker due to its ease; when greater accuracy is required for axis marking, Dr. Tchah will utilize a slit lamp. For automatic axis marking, a good way to compensate for cyclotorsion, new software such as the Catalys® cOS 6.0 can be used. Finally, Dr. Tchah recommends customizing the nomogram considering each surgeon's factors for better results as he has found that original nomogram settings may overcorrect astigmatism.

From the discussion with the panelists, toric IOLs, especially the new TECNIS® Toric II IOL, have provided significantly improved patient outcomes. Femtosecond laser-assisted surgery in low to moderate astigmatic cases has shown stable effects over the long term, and the TECNIS® Toric II IOL has been very successful in patients with high astigmatism. Using toric IOLs along with toric calculations to target as close to zero astigmatism as possible will highly benefit both the surgeon and patient.

References:

1. Lee BS et al. Ophthalmology 2018.
2. Roberts HW et al. J Cataract Refract Surg 2018.
3. Wendelstein JA et al. Acta Ophthalmol 2021.
4. Wortz G et al. Clin Ophthalmol 2020.

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