Toric IOLs: Myth Versus Reality

Debunking some of the conventional wisdom about the implantation of these lenses.

BY IKE K. AHMED, MD, FRCSC

A large percentage of the people presenting for cataract surgery have visually significant astigmatism. A recent analysis of corneal cylinder concluded that more than 36% of the population has at least 1.00 D of astigmatism,[1] and another found that 41% have 0.75 D or more.[2]

For good uncorrected distance vision, we surgeons must achieve a refractive result of less than 0.75 D of astigmatism. In truth, I want to get that amount as close to zero as possible. Studies have shown that astigmatism of as little as 0.50 D can reduce visual acuity by 1 line and that its impact on dynamic, functional visual acuity and low-contrast acuity is even greater.[3] Moreover, ocular surface problems and computer usage—both common in the cataract population—magnify the impact of even minimal residual astigmatism on patients' ocular comfort and performance.[4-6]

For low levels of astigmatic correction, limbal relaxing incisions or laser arcuate incisions at the time of cataract surgery may suffice. In many cases, however, a toric IOL represents the best option for full correction.

Canadian surgeons such as myself have access to a number of toric lenses, including the AcrySof Toric (Alcon Laboratories, Inc.), the STAAR Toric (STAAR Surgical Company), the Rayner T-Flex Toric (Rayner Intraocular Lenses Ltd.), the Zeiss Acri.Lisa Toric, and the Tecnis Toric (Abbott Medical Optics Inc.; Figure 1). This article examines five pieces of conventional wisdom about the implantation of toric IOLs that may not serve us (or our patients) well.

No. 1. NEVER FLIP THE AXIS

Most of us were taught never to flip the axis in cataract surgery. This is generally good advice when we are prescribing spectacles, because patients have difficulty tolerating astigmatism in the axis opposite their accustomed axis. When we are reducing the astigmatism nearly to zero with a toric IOL at the nodal point of the eye, however, this optical principle is less useful.

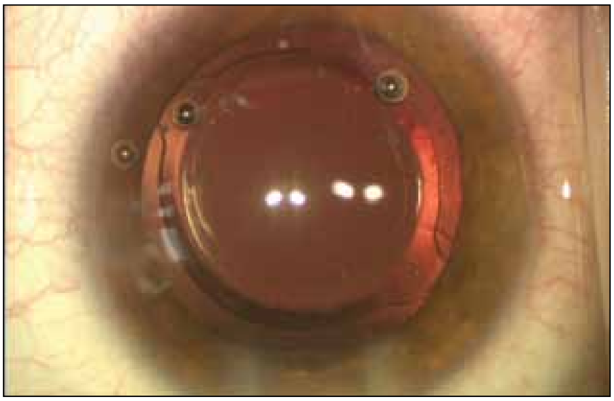

Figure 1. A Tecnis Toric IOL in the eye.

In a study of 40 eyes with high preoperative keratometric cylinder (> 2.50 D), Hoffmann and colleagues found that overcorrection leading to a flipped axis was well tolerated and typically still provided spectacle independence.[7] Flipping occurred in 42.5% of the eyes with an average residual cylinder of 0.77 D.

In Figure 2, the red arrow points to my IOL choice for a patient. Although model ZCT225 of the Tecnis Toric IOL flips the axis to 110º, it leaves the eye with only 0.02 D of cylinder, which is better than 0.43 D, the best result I can obtain if I keep the axis at 20º. The residual cylinder in this case will be so close to zero that it will be imperceptible to the patient, who will easily tolerate the flipped axis. I always choose the IOL that will provide

FREE ONLINE CALCULATOR FOR TORIC IOL PLANNING AND POSTOPERATIVE ANALYSES

By Noel Alpins, FRANZCO, FRCOphth

I developed the Alpins Statistical System for Ophthalmic Refractive Surgery Techniques (ASSORT) as a total ophthalmic surgical analysis system that integrates all measurable ophthalmic parameters, including visual acuities and personalized A-constants. The system innovatively analyzes vectors for astigmatic changes. A well-known benefit of ASSORT is that the method of astigmatic analysis is displayed both numerically and graphically in a manner that is clear and easy to follow. The approach determines a goal for astigmatic correction and the treatment required to achieve that goal. The method also allows the calculation of the principal components by which an operation fails to achieve its goal. Other components assist in comparing the results of astigmatism surgery for individuals and groups of individuals using the ophthalmologist's own computerized data. Surgeons can then use these reports to adjust their nomograms for future incisional and ablative procedures.

A new module of the ASSORT suite of software is the updated toric IOL calculator. This is now available as a free online toric calculator (www.assort.com) that can be used for choosing the best implant from all commercially available toric lenses. The software calculates the spherical and cylindrical IOL powers required to target emmetropia or any other refractive target specified by the user. The software allows for the use of surgeon-personalized IOL constants together with the specified axial length using SRK/T, Holladay 1, Hoffer Q, or Haigis formulas to determine a more accurate effective lens position. Some of the software's other features include the option to select the most appropriate corneal refractive index for the instrument used to determine corneal astigmatism, a display of the expected spherocylindrical refraction for all available toric IOLs for the parameters entered, dynamic graphics of the effect of the phaco incision on the corneal astigmatism, and the ability to capture all the data entered to order the selected toric IOL from the manufacturer.

A particularly helpful feature is the system's postoperative analyses for magnitude and axis of toric implants with refractive surprises. The free toric calculator module helps the surgeon to determine the best treatment option for cases where a refractive cylinder surprise has occurred. The options include rotating the existing IOL if the resulting refractive cylinder can be significantly reduced (degree and direction of IOL rotation are displayed), exchanging the toric IOL for a more suitable one if the toric power was too strong or too weak, or performing excimer laser surgery to correct for spherocylinder remaining.

The online toric IOL calculator will display the expected spherocylindrical refraction for any amount of IOL rotation selected postoperatively. In some cases, postoperative examination will show the IOL to be at the planned axis, but a refractive cylinder surprise may still occur due to other factors such as "nonlens" ocular residual astigmatism originating from somewhere else in the ocular system, including visual processing in the cortex of the brain. The

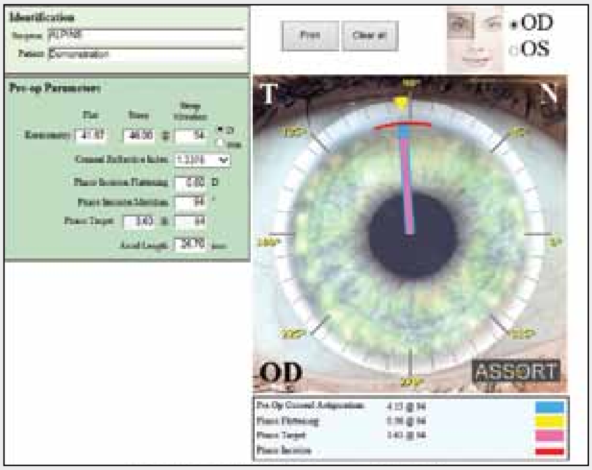

Figure 1. Displays the input parameters required together with the graphical representation of the effect of the phaco incision on the corneal astigmatism.

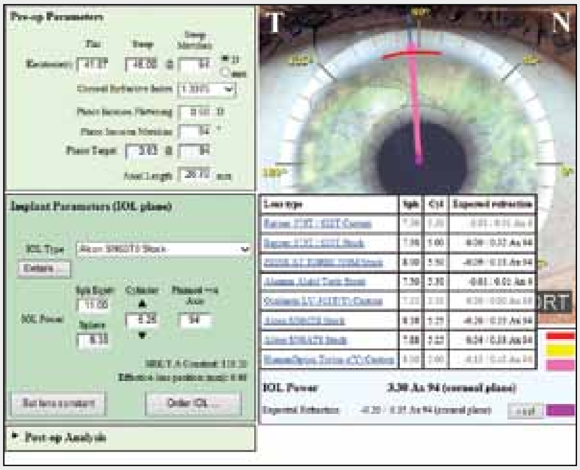

Figure 2. The expected spherocylindrical refraction is calculated for each of the toric IOLs that are suitable given the preoperative parameters entered. The customized IOLs appear in light grey. In addition, the effective lens position using a personalized A-constant is calculated.

FREE ONLINE CALCULATOR FOR TORIC IOL PLANNING AND POSTOPERATIVE ANALYSES (CONTINUED)

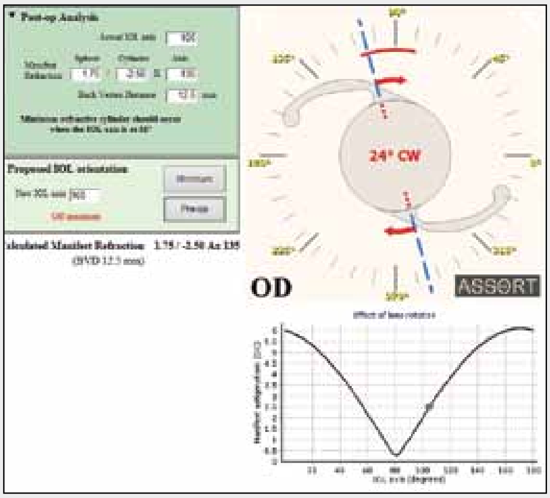

Figure 3. Postoperative toric IOL analysis requires input of the IOL axis and the manifest refraction. The graphics display the amount and direction of IOL rotation required to achieve the minimum refractive cylinder (rotate IOL axis to 81º). This is also indicated by the bottom point on the parabolic function shown.

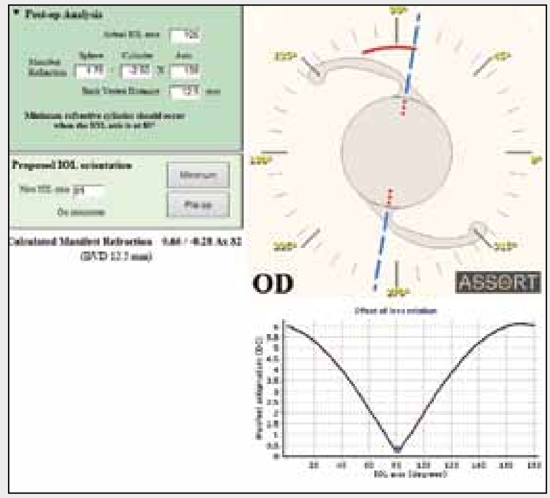

Figure 4. Once the toric IOL is rotated to the recommended 81º, the expected refraction is +0.66/-0.28 x 082º. This is significantly better than +1.75/-2.50 x 135º that was achieved initially.

Alpins Method ASSORT

SIA	4.71	Ax	20
TIA	3.50	Ax	4
Difference Vector	2.59	Ax	131
Correction Index	1.43		
Index of Success	0.78		
Magnitude of Error	1.41		
Angle of Error	16 (CCW)		

Figure 5. The Alpins method of analysis displays whether the toric IOL is too strong or too weak astigmatically using the magnitude of error. In this case, the astigmatism has been overcorrected. In addition, the angle of error is calculated displaying an error of 16º counterclockwise and, hence, a clockwise rotation required to correct for it.

ASSORT toric IOL planner offers the calculations in an easy-to-comprehend display showing all of the required vectors.

My team and I strove to allow users to follow the calculations and apply them in surgery to improve visual outcomes (Figures 1-5). We will continue to add new toric IOLs to the software as they are developed.

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the smallest absolute astigmatic error, even if that means flipping the axis.

No. 2. GET WITHIN 10º OF THE INTENDED AXIS

With modern patients' expectations for cataract surgery—especially refractive cataract procedures for which they are paying out of pocket—a result within 10º of the intended axis simply is not good enough. Misalignment of a toric IOL significantly decreases its efficacy. The approximately 3.3% loss of effect for every degree of misalignment means that being 10º off will result in an undercorrection of nearly 35%.[8] When implanting a toric IOL, we should be aiming for as precise an alignment of the axis as possible, ideally within 5º of the intended axis.

Such precision demands that we address all potential sources of error in the power and axis calculation. Some of these are under our direct control, including preoperative biometry measurements, marking, assumptions about the surgically induced astigmatism (SIA), and the IOL's alignment. Other factors such as posterior corneal astigmatism, corneal anatomy, capsular healing, and effective lens position may be more difficult to control.

We can improve our accuracy by using the IOLMaster (Carl Zeiss Meditec, Inc.) or Lenstar LS900

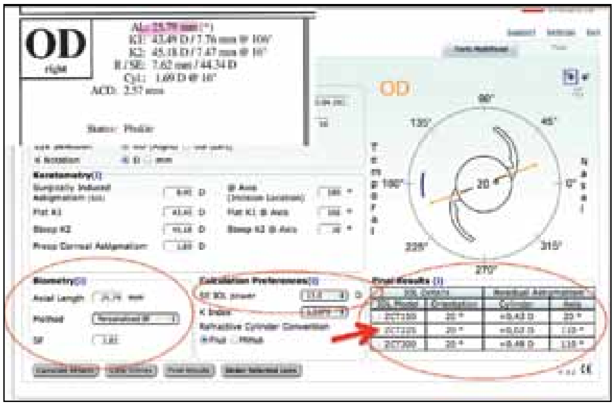

Figure 2. A toric IOL calculator that incorporates the Holladay 1 formula and allows the surgeon to pick from several IOL power choices, including flipping the axis if desired, is advantageous.

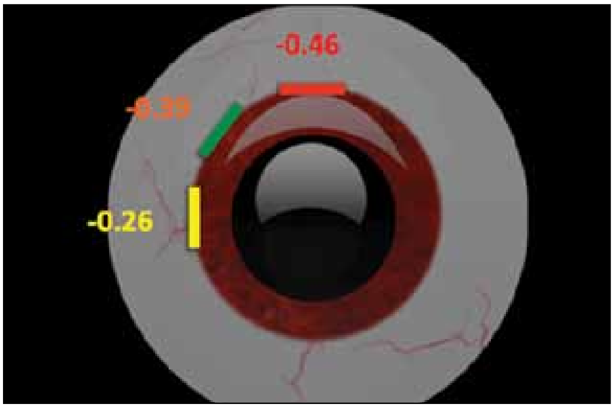

Figure 4. Smaller, more limbal incisions tend to induce less astigmatism. As in this example, a temporal incision produces less SIA than a superior incision. Data adapted from Rho et al.[9]

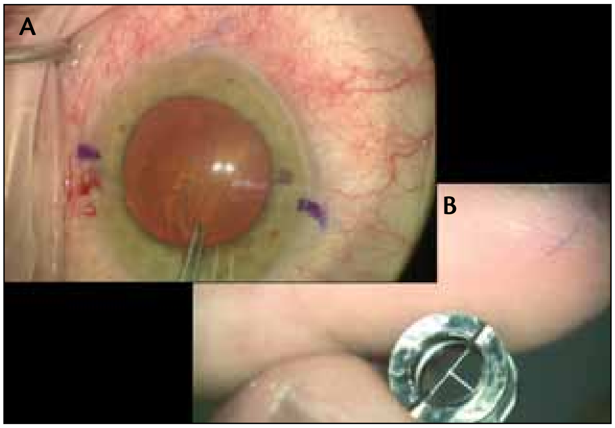

Figure 3. Ink marks on the cornea sometimes provide less benefit in terms of the precise orientation of the axis (A). Dr. Ahmed instead uses an inkless, beveled marking tip to indent the epithelium (B).

(Haag-Streit AG) for keratometry and by verifying the location of the axis and magnitude of astigmatism on topography. Dry eye disease can dramatically affect astigmatism, so whenever the measurements do not agree, I instill artificial tears to improve the repeatability of the measurements. Our surgical technique must be very consistent, particularly the capsulorhexis. Finally, we should choose lenses that offer excellent rotational stability.

No. 3. PREOPERATIVE MARKING IS NOT THAT IMPORTANT

Preoperative marking of the axis to account for cyclotorsion and to facilitate the correct alignment of a toric IOL is essential. Although most of us place marks, many of us often do so haphazardly.

Numerous tools are available for marking the axis. Some surgeons identify the 3-, 6-, and 9-o'clock positions preoperatively and then mark the steep axis intraoperatively. I prefer to use a one-step system to mark the steep axis preoperatively. Whatever the approach, it is important to make a careful and precise mark. Too thick an ink mark (Figure 3A) can itself have several degrees of variance, so I prefer an inkless, beveled marking tip (Figure 3B) to indent the epithelium.

No. 4. THE STEEP AXIS SHOULD DETERMINE THE INCISIONS' PLACEMENT

A common belief is that adjusting making the entry wound on the steep axis is an effective way of correcting astigmatism. An on-axis incision can flatten the cornea by 0.20 to 0.80 D and may be appropriate when we do not intend to use a toric IOL or to make limbal relaxing or arcuate incisions. The downside to using this approach is that it greatly reduces the predictability of each ophthalmologist's SIA.

SIA varies considerably based on the location and type of incision. For example, Rho et al found that superior incisions induced nearly twice as much SIA as temporal ones (Figure 4).[9] Others have shown that larger and more central incisions induce more astigmatism.[10-12] To achieve the best results, we should each determine our personal SIA. The calculator (www.doctor-hill.com) of Warren Hill, MD, is a very useful tool for this purpose.

I prefer to make incisions that are temporal, limbal, less than 2.4 mm wide, and 2 mm long. It is impossible to know exactly how much astigmatism will be induced in a given eye, but consistency in wound architecture and the incision's placement will certainly increase the predictability of the SIA.

No. 5. TORIC IOL CALCULATORS ARE ALL THE SAME

Every manufacturer of a toric IOL provides a calculator program for choosing which lens to use for a given patient. Some of these calculators incorporate more data than others, so it is important to understand what assumptions the calculators make. Most assume a fixed ratio between the IOL and the corneal plane, based on the average pseudophakic human eye (ie, 1.46 D at the IOL plane = 1.00 D at the corneal plane, and 1.00 D at the IOL plane = 0.68 D at the corneal plane). Unfortunately, these assumptions do not always hold true for large or small eyes or those with an unusually deep or shallow anterior chamber.

Perhaps a better approach is to use vergence equations based on the Holladay 1 formula. For example, the Tecnis Toric IOL calculator (Figure 2) incorporates the Holladay 1 formula, with the cylindrical correction based on the calculated effective lens position. It also provides me with several IOL power choices and the anticipated residual cylinder for each so that I can decide whether I wish to flip the axis to achieve the lowest residual cylinder.

CONCLUSION

As we strive to improve surgical outcomes for astigmatic patients, it is important that we critically evaluate the conventional wisdom on toric IOLs. Much of it does not hold true for the latest generation of lenses and today's expectations. ■

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