Long-term clinical outcomes of toric intraocular lens implantation in cataract cases with preexisting astigmatism

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PURPOSE: To evaluate the long-term clinical outcomes and rotational stability of toric intraocular lenses (IOLs) to correct preexisting astigmatism in cataract patients.

SETTING: Kitasato University Hospital, Kanagawa, Japan.

DESIGN: Prospective observational study.

METHODS: Phacoemulsification with implantation of a toric IOL (Acrysof IQ toric SN6AT) was performed in cataract patients with corneal astigmatism. The postoperative follow-up was up to 2 years.

RESULTS: This study enrolled 378 eyes of 302 patients with a mean age of 63.4 years ± 16.9 (SD). The corrected distance visual acuity 3 months postoperatively was 20/25 or better in 94.7% of eyes. The mean refractive cylinder was −1.92 ± 1.45 diopters (D) preoperatively, −0.59 ± 0.62 D 3 months postoperatively (322 eyes), and −0.67 ± 0.90 D at 2 years (73 eyes). There were statistically significant differences between the preoperative and 3-month postoperative measurements (P<.001, Wilcoxon signed-rank test). The mean IOL misalignment was 4.1 ± 3.0 degrees 2 years postoperatively. The mean IOL rotation was 4.5 ± 4.9 degrees within 1 day postoperatively. The rotation was more than 20 degrees in 6 eyes, all of which had an axial length (AL) of more than 25.0 mm. All rotations occurred within 10 days postoperatively.

CONCLUSIONS: Toric IOLs were effective in reducing preexisting corneal astigmatism and had overall good rotational stability. A large degree of IOL rotation might occur in eyes with a relatively long AL, especially during the early postoperative period. The 6 rotated IOLs were implanted to correct with-the-rule astigmatism.

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Major developments in cataract surgery have contributed to significant improvement in visual outcomes. One development is the improvement in intraocular lens (IOL) design as well as the availability of premium IOLs. Another is a shift to smaller corneal incisions for IOL implantation. As a result, better quality of vision after cataract surgery has been obtained in recent years. Therefore, the management of preexisting corneal astigmatism has become clinically more important.[1]

Surgical options for correcting preoperative astigmatism include the size and position of the main incision,[2] astigmatic keratotomy,[3] limbal relaxing incisions,[4] and implantation of toric IOLs. The toric IOL was devised by Shimizu et al.[5] in 1994 and has been widely used in clinical settings. A major problem of the technique is postoperative rotation of the toric IOL.[6–8]

The purpose of this study was to prospectively assess the long-term visual and refractive outcomes and rotational stability of toric IOL implantation.

PATIENTS AND METHODS

This prospective observational study included consecutive patients with cataract and preexisting regular corneal

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astigmatism who had implantation of an Acrysof IQ toric SN6AT IOL (Alcon Laboratories, Inc.) at Kitasato University Hospital between August 2009 and July 2012. The toric IOL was approved for clinical use in Japan in August 2009.

Inclusion criteria included cataract and preoperative regular corneal astigmatism. Exclusion criteria included preoperative irregular corneal astigmatism, a history of glaucoma or retinal detachment, corneal disease, previous corneal or intraocular surgery, an abnormal iris, pupil deformation, macular degeneration or retinopathy, neuro-ophthalmic disease, and a history of ocular inflammation.[9,10]

The uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), refractive cylinder, and corneal astigmatism were recorded preoperatively and 1 day, 1 week, 3 months, and 1 and 2 years postoperatively. Intraocular lens misalignment and IOL rotation were measured at all postoperative visits. Minus cylinder notation was used in this study.

Preoperatively, corneal astigmatism was determined with an autokeratometer (ARK-700A, RKT-7700, Nidek Co. Ltd.) and corneal topography evaluated (Atlas, Carl Zeiss Meditec AG). Preoperative corneal astigmatism and axial length (AL) were measured with an optical biometer (IOLMaster, Carl Zeiss Meditec AG). Manual keratometry was not used to determine IOL orientation. Calculation of IOL power, axis placement of the IOL, and the appropriate IOL model was performed using a program available from the IOL manufacturer.[A]

Digital anterior segment photographs were taken to determine the alignment of the toric IOL axis postoperatively. A blood vessel of the bulbar conjunctiva, the pigment of the bulbar conjunctiva, or the iris pattern in the photographs was selected as a reference point. The axis of IOL rotation was measured by comparing the follow-up photographs with the photographs taken immediately postoperatively. In all cases, the photographs were confirmed to be of sufficient quality to allow determination of the amount of IOL rotation.

For accurate astigmatic correction, it is important to control for potential ocular cyclotorsion caused by changes in the patient's position. The mean ocular cyclotorsion has been reported to be 2.59 $\pm$ 1.91 (SD) degrees, which was not negligible in a clinical setting.[11] In this study, preoperative marking was performed by the same examiner (T.M.). Using the axis-registration method, horizontal marks were made on the cornea and conjunctiva using an axis marker (AE-2748, American Surgical Instruments Corp.) under a slitlamp with the patient seated. The marking on the conjunctiva was used to identify the steepest meridian on the corneal topographic image (TMS-5, Tomey Corp.), and the marking on the cornea was used to identify the steepest meridian during the toric IOL implantation. The marking on the conjunctiva was easily identified on the topographic image, allowing confirmation of the graphic relation between the mark and the steepest meridian.[12]

Surgical Technique

The surgery was performed by 1 of 2 experienced surgeons (K.S., K.K.).With the patient supine on the surgical table, the corneal limbus of a direction fixing the axis of the toric IOL was marked with a 30-gauge needle with the aid of the premarked reference point. The 30-gauge needle was used to allow easy measurement of IOL misalignment immediately after surgery. Next, phacoemulsification was performed through a 2.65 mm temporal corneal incision and the toric IOL inserted in the capsular bag. After the ophthalmic viscosurgical device (OVD) was removed, the surgeon rotated the toric IOL to align with the reference marks on the cornea. No sutures were used to close the wound.

Astigmatism Analysis

Vector analysis was performed using the Alpins method.[6,7,13,14] Terms used to describe the change in refractive cylinder were as follows:

1. Target induced astigmatism vector (TIA), which is the astigmatic change (by magnitude and axis) the surgery was intended to induce.
2. Surgically induced astigmatism vector (SIA), which is the amount and axis of astigmatic change the surgery actually induced.
3. Astigmatism correction index, which is calculated by determining the ratio of the SIA to the TIA by dividing the SIA by the TIA. The preferable astigmatism correction index is 1.0. It is greater than 1.0 if overcorrection occurs and less than 1.0 if undercorrection occurs.
4. Angle of error, which is the angle described by the vectors of the achieved correction (SIA) versus the intended correction (TIA). The angle of error is positive if the achieved correction is counterclockwise to its intended axis and negative if the achieved correction is clockwise to its intended axis.
5. Difference vector, which is the induced astigmatic change (by magnitude and axis) needed for the initial surgery to achieve its intended target. The difference vector is an absolute measure of success, and the preferable value is zero.
6. Flattening effect, which is the amount of astigmatism reduction achieved by the effective proportion of the SIA at the intended meridian (flattening effect = SIA Cos2 $\times$ angle of error).
7. Flattening index, which is calculated by dividing the flattening effect by the TIA. The preferable value is 1.0.
8. Index of success, which is calculated by dividing the difference vector by the TIA. The index of success is a relative measure with a preferable value of zero.

Statistical Analysis

The means and standard deviation were calculated using Excel 2010 software (Microsoft Crop.). All statistical

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