

Visual function and patient experience after bilateral implantation of toric intraocular lenses

Iqbal Ike K. Ahmed, MD, Guillermo Rocha, MD, Allan R. Slomovic, MD, Harold Climenhaga, MD, Jit Gohill, MD, Alain Grégoire, MD, Joseph Ma, MD
for the Canadian Toric Study Group*

PURPOSE: To evaluate the efficacy, stability, predictability, and patient-reported outcomes of bilateral toric intraocular lens (IOL) implantation in cases of cataract with preexisting astigmatism.

SETTING: Fourteen universities, hospitals, or private practices, Canada.

METHODS: Patients with cataracts and corneal astigmatism from 1.00 to 2.50 diopters (D) were included in a prospective study of bilateral AcrySof toric IOL implantation. Binocular uncorrected distance visual acuity (UDVA), manifest refraction, and IOL rotational stability were assessed 1 day and 1, 3, and 6 months postoperatively. Patients completed a questionnaire that assessed spectacle independence, visual disturbances, and satisfaction with vision (1 = completely unsatisfied; 10 = completely satisfied) preoperatively and 3 and 6 months postoperatively.

RESULTS: The study included 117 patients (234 eyes). The binocular UDVA was 20/40 or better in 99% of patients and 20/20 or better in 63% of patients. The mean residual refractive astigmatism was $0.4 \text{ D} \pm 0.4$ (SD). The spherical equivalent was within $\pm 0.5 \text{ D}$ of target in 77% of eyes. At last observation, IOL alignment was within ± 5 degrees in 91% of eyes and within ± 10 degrees in 99%. Sixty-nine percent of patients reported never using distance spectacles. The frequency and severity of halos and glare were significantly reduced from preoperatively to postoperatively. Satisfaction with vision was rated 7 or higher by 94% of patients.

CONCLUSION: Bilateral implantation of toric IOLs yielded excellent and stable visual outcomes that patients rated as highly satisfactory.

Financial Disclosure: No author has a financial or proprietary interest in any material or method mentioned. Additional disclosures are found in the footnotes.

J Cataract Refract Surg 2010; 36:609–616 © 2010 ASCRS and ESCRS

 Members of the study group listed online (www.jcrsjournal.org).

Many cataractous eyes have some amount of clinically significant astigmatism.¹ In a definitive biometry study of 7500 cataractous eyes,¹ corneal astigmatism of 0.75 to 1.50 diopters (D) was observed in 41% of patients and of more than 1.50 D in 18% of patients. Implantation of toric intraocular lenses (IOLs) is an option to compensate for corneal astigmatism in cataract patients. An important criterion for evaluating toric IOLs is their rotational stability because alignment is critical in compensating for corneal cylinder and thus producing good uncorrected distance visual acuity (UDVA). Each degree of rotation causes an average loss of cylinder power of approximately 3%; thus, when an IOL rotates 30 degrees there is no astigmatic correction, although there is a change of axis.^{2,3}

With the AcrySof toric IOL (Alcon, Inc.), alignment was within ± 5 degrees in 78% of eyes in clinical trials (product information, Alcon, Inc., 2005) and was within ± 5 degrees in 77% to 95% of eyes in recent studies.^{4–6} This toric IOL has not been widely studied bilaterally. The original clinical trials were based on unilateral implantation, and recent reports are limited to 10 to 15 patients with bilateral implantation.^{4,5,7} Moreover, patient-reported experiences, such as spectacle use, satisfaction, and visual disturbances, were not reported in these studies. The purpose of this study was to evaluate the objective visual outcomes and subjective visual experiences of a large group of cataract patients bilaterally implanted with AcrySof toric IOLs to evaluate the utility of bilateral implantation as a strategy for correction of astigmatism at the time of cataract surgery.

PATIENTS AND METHODS

Patient Enrollment and Baseline

Physician members of the Canadian Toric Study Group, a multicenter affiliation of 14 surgeons, prospectively enrolled patients who were at least 21 years old and had age-related cataract in both eyes. In accordance with the Declaration of Helsinki, each patient provided consent. An institutional review board approved the study.

Eligibility criteria included eyes requiring 10.00 to 30.00 D spherical IOL correction with preoperative regular corneal astigmatism from 1.00 to 2.50 D. Exclusion criteria were characteristics that could compromise visual outcomes, such as irregular astigmatism, corneal abnormalities, corneal edema, corneal dystrophy, previous corneal reshaping, medically uncontrolled glaucoma, and the presence or a history of a defined list of other eye diseases, disorders, or inflammation.

Submitted: April 13, 2009.

Final revision submitted: October 4, 2009.

Accepted: October 7, 2009.

From a private practice (Ahmed), Mississauga, Toronto Western Hospital, University Health Network (Slomovic), and North York General Hospital and Herzig Eye Institute (Ma), Toronto, Ontario; Brandon Regional Health Authority (Rocha), Brandon, Manitoba; Royal Alexandra Hospital and University of Alberta (Climenhaga), Edmonton, and University of Calgary (Gohill), Calgary, Alberta; Centre Hospitalier Universitaire de Sherbrooke (Grégoire), Sherbrooke University, Sherbrooke, Quebec, Canada.

Additional financial disclosures: Dr. Ahmed is a consultant to and has received research funding from Alcon, Inc., Canada; Dr. Blylock is a consultant to Alcon, Inc., Canada; Dr. Rocha is a consultant to Bausch & Lomb, Allergan, Inc., Merck Frosst Canada Ltd., and Alcon, Inc., Canada, and has received research grants from Alcon, Inc., Canada, and Bausch & Lomb; Dr. Slomovic is a consultant to and has received research grants from Alcon, Inc., Canada, and is a consultant to Allergan, Inc.

Presented in part at the Canadian Society of Cataract and Refractive Surgery, Ottawa, Canada, October 2007; Canadian Ophthalmological Society, Montreal, Canada, June 2007, and Whistler, Canada, June 2008; XXVI Congress of the European Society of Cataract & Refractive Surgeons, Berlin, Germany, September 2008; ASCRS Symposium on Cataract, IOL and Refractive Surgery, Chicago, Illinois, USA, April 2008.

Funded by Alcon, Inc., Canada (protocol number ALCONsurto001.06).

Alcon employees assisted with the preparation of the manuscript.

Corresponding author: Ike K. Ahmed, MD, Credit Valley Eye Care, 3200 Erin Mills Parkway, Unit 1, Mississauga, Ontario, L5L 1W8, Canada. E-mail: ike.ahmed@utoronto.ca.

Preoperative Assessment

At the preoperative assessment, patients completed a structured 11-item questionnaire about satisfaction with their vision, spectacle use, and visual disturbances (halos and glare). The questionnaire was not a validated instrument. The 5 questions to assess spectacle use were based on the structure of similar questions in the validated Cataract TyPE Instrument⁸ and on the structure of questions in clinical trials of toric and multifocal IOLs (AcrySof Toric Single-Piece Natural IOL Product Information, 2005, and AcrySof IQ ReSTOR Multifocal IOL Physician Labeling, 2009, Alcon, Inc., Fort Worth, Texas). The first question was "How often do you wear spectacles?" Response options were always, sometimes, or never. The second question was "Specify the frequency with which you have needed glasses for seeing distance objects or distance activities," with response options as follows: never, rarely, occasionally, often, or always. Three other questions assessed the patient's use of spectacles for distance vision during the day, at night, and indoors. Four questions assessed the patient's experience of halos and glare in terms of their frequency (never, rarely, occasionally, often, or always) and severity (none, mild, moderate, or severe). One question assessed the type of vision correction (eg, bifocals, trifocals, reading glasses). The final question assessed patient satisfaction with vision on a scale of 1 (completely unsatisfied) to 10 (completely satisfied).

The UDVA and corrected distance visual acuity (CDVA) were tested monocularly and binocularly using logMAR charts. Manifest refraction was measured using a phoropter. Axial length was measured using the IOLMaster partial coherence interferometry (PCI) biometer (Carl Zeiss Meditec AG), applanation ultrasound, or immersion ultrasound. Keratometry was most often measured automatically (by PCI biometry or autokeratometry), although manual keratometry was allowed. Corneal topography was optional. In cases in which corneal topography was not available, irregular astigmatism was ruled out by examining the ophthalmic history or by comparing refractive astigmatism against corneal astigmatism. Irregular astigmatism was suspected in patients who had a pre-cataract eye examination that showed no corneal pathology and no amblyopia but showed that distance vision could not be spectacle corrected to at least 20/20 Snellen; these eyes were excluded from the study. Alternatively, irregular astigmatism was ruled out by eliminating any eye with suspiciously high keratometry (K) readings (>47.00 D) and then eliminating any eye with corneal astigmatism that did not match the refractive astigmatism. When data were available from PCI biometry and autokeratometry, an eye could be excluded from the study if the K values from both

instruments did not match within ± 5 degrees (desired) or within ± 10 degrees (absolute limit).

For each eye, the relevant preoperative assessment parameters, including flat and steep K values and the axis of each, were entered into an online toric IOL calculator (Available at: <http://www.acrysoftoriccalculator.com>. Accessed December 7, 2009) to determine the axis placement of the IOL and the appropriate IOL model. Table 1 shows the toric IOL models used in the study. The calculator has a default value for surgically induced astigmatism (SIA) of 0.50 D, which is typical for surgeons using incision sizes in the 2.4 mm range.⁹ However, surgeons in this study who knew their own SIA value could enter that value instead of the default. The calculator also requires surgeons to choose the axis location of the incision, allowing manipulation of SIA to yield the lowest residual cylinder.⁹ No deviation from the IOL model and orientation specifications yielded by the calculator was allowed.

Surgical Technique

The first surgeries in the study were performed in September 2006. Most patients in this study were among the first cases of AcrySof toric IOL implantation for each surgeon. Methodology used with early patients could be modified as surgeons gained experience with the toric IOL. This included refinements of axis-marking techniques.

Marking techniques varied by surgeon but had similarities. Preoperatively, initial markings were made with the patient sitting up to avoid cyclorotation. The eye could be marked at 0 degrees and 180 degrees using an instrument such as a Bakewell BubbleLevel (Mastel, Inc.) or a Nuijts/Lane Toric Reference Marker (American Surgical Instruments Corp.). During surgery, these reference marks were used to determine the desired axis of IOL orientation, which then was marked using an instrument such as a Bores Meridian (Axis) marker with a Gimbel/Mendez ring (Mastel, Inc.) or a Mendez ring with a Nuijts toric axis (American Surgical Instruments Corp.). Alternatively, the eye could be preoperatively marked (at 0 degrees and 180 degrees or at desired alignment angle) while

using a slitlamp, which could be equipped with an angle-measuring reticule eyepiece (Haag-Streit AG).³ Some surgeons began their case series using hand instruments and later found that marking the eye while using a slitlamp produced better results. Depending on methodology, marking could be performed with dye, ink, or a needle (used to puncture a perilimbal vessel or to create a superficial epithelial abrasion).

Surgeons could operate temporally or could place the incision on the steepest axis of astigmatism. The IOL was placed in the capsular bag using the Monarch II Delivery System with the B or C cartridge (Alcon, Inc.). Gross alignment (within 20 to 30 degrees of desired axis) was performed by rotating the IOL clockwise while it was unfolding. The ophthalmic viscosurgical device was gently removed from behind the IOL before the toric IOL was moved clockwise into final axis alignment. No limbal relaxing incisions or any other surgical procedures were allowed. Surgery on the second eye followed 7 to 30 days after surgery on the first eye. Postoperative management followed each surgeon's standard of care and could be tailored to the needs of each patient at the 1-day postoperative assessment.

Postoperative Assessment

Initial postoperative examinations were performed 1 day after implantation of each IOL. All subsequent postoperative examinations were designated from the date of the second IOL implantation: 1 month (± 7 days), 3 months (± 14 days), and 6 months (± 30 days). At every postoperative examination, toric IOL orientation was determined by examining the eye at the slitlamp and noting the IOL axis, designated by 6 laser marks on the optic of the IOL. Manifest refraction and monocular and binocular UDVA and CDVA were assessed at 1, 3, and 6 months. The subjective questionnaires were distributed at 3 and 6 months.

Statistical Analysis

Data were analyzed using Excel 2002 software (Microsoft Corp.) and the StatSoft statistical data analysis software system (version 8.0, StatSoft, Inc.). The Student *t* test was used for parametric variables and a chi-square test for categorical variables. All results are presented as the mean \pm SD unless otherwise noted.

RESULTS

Patients

The physicians enrolled 120 patients (240 eyes). The mean age of the 41 men (34.2%) and 79 women (65.8%) was 68 ± 11 years. Ethnicity demographics were available for 108 patients (90.0%) and were as follows: 74.1% white, 22.2% Asian, and 3.7% other. The mean preoperative corneal astigmatism was 1.7 ± 0.4 D;

Table 1. AcrySof toric intraocular lens (IOL) models.

Model	Cylinder Power (D)		
	At IOL Plane	At Corneal Plane	Recommended Corneal Astigmatism Correction (D)
SN60T3	1.50	1.03	0.75–1.50
SN60T4	2.25	1.55	1.50–2.00
SN60T5	3.00	2.06	2.00–2.50

IOL = intraocular lens

astigmatism was confirmed as regular by corneal topography in 204 eyes (85.0%). Astigmatism was against the rule (ATR) in 88 eyes (37.6%), oblique in 11 eyes (4.7%), and with the rule (WTR) in 141 eyes (60.3%).

Follow-up

Three patients declined to have an IOL implanted in the second eye or did not return for the second surgery. Of these patients, 1 was lost to all follow-up visits and the other 2 returned for postoperative visits at 3 months, 6 months, or both. The spherical equivalent (SE) in the operative eyes of these 2 patients was -0.125 D and -0.250 D; they rated their satisfaction as 6 and 9, respectively. Unilateral results are excluded from all subsequent sections of this paper.

Of the 117 patients with bilateral IOLs, all attended the follow-up 1 day after the first IOL implantation and 114 attended 1 day after the second IOL implantation; 115 attended the 1-month follow-up, 99 attended the 3-month follow-up, and 89 attended the 6-month follow-up. At the postoperative visits, not all patients received every ophthalmic assessment metric (eg, 1 site may have assessed visual acuity but not IOL axis). Questionnaires were completed by 78 patients preoperatively, 89 patients 3 months postoperatively, and 78 patients at 6 months. No preoperative questionnaires were on file for at least 1 patient to as many as 11 patients at each site; the mean number of questionnaires missing per site was 4 ± 3 . The questionnaires were missing because they were not distributed to or were not returned by patients.

Surgical Parameters

Of the 233 eyes of bilateral patients with model numbers noted in the case files, 90 (38.6%) had implantation of a model SN60T3 IOL, 94 (40.3%) of a model SN60T4 IOL, and 49 (21.0%) of a model SN60T5 IOL. The mean incision size was 2.9 ± 0.2 mm (range 2.2 to 3.2 mm). The target SE was noted for 192 eyes. Of those, the target was emmetropia in 146 eyes (76.0%) and was within ± 0.50 D of emmetropia in 187 eyes (97.4%). No eye had a target less than -1.00 D.

Of patients whose files had notes regarding eye-drops 1 day postoperatively, the most common prescription was a combination of moxifloxacin, diclofenac, and dexamethasone 2 to 4 times a day. No serious complications were noted in the surgical files or in the 1-day postoperative files, although corneal edema was noted in 7 eyes.

Refractive and Corneal Astigmatism

Figure 1 shows the 6-month postoperative residual refractive astigmatism and the preoperative corneal

astigmatism in 164 eyes. At 6 months, 148 eyes (90.2%) had 1.00 D or less of refractive astigmatism, 140 eyes (85.4%) had 0.75 D or less, 116 eyes (70.7%) had 0.50 D or less, and 75 eyes (45.7%) had 0.25 D or less. The mean residual refractive astigmatism was 0.4 ± 0.4 D, which was statistically significantly lower than preoperative corneal values ($P < .001$, paired *t* test). The mean reduction in astigmatism was $70\% \pm 30\%$ in eyes with a model SN60T3 IOL, leaving a mean residual astigmatism of 0.4 ± 0.4 D; $70\% \pm 20\%$ in eyes with a model SN60T4 IOL, leaving a mean residual astigmatism of 0.4 ± 0.4 D; and $70\% \pm 30\%$ in eyes with a model SN60T5 IOL, leaving a mean residual astigmatism of 0.5 ± 0.5 D.

No eyes had an increase in cylinder (preoperative cylinder to 6-month postoperative refraction). However, 2 eyes with a model SN60T3 IOL had no apparent reduction in cylinder. Both eyes had 1.25 D of corneal cylinder preoperatively and 1.25 D of refractive cylinder 6 months postoperatively. The residual cylinder was not the result of IOL rotation, which was within ± 7 degrees from the operative axis in both eyes at all postoperative assessments. At 1 month, both eyes had a reduction in cylinder (to 0.75 D and to 0.50 D, respectively). Cylinder in both eyes then increased during the postoperative follow-up, although the 2 IOL axes changed 3 degrees or less from 1 day to 6 months postoperatively.

Of the 89 eyes that had 0.50 D or more of refractive astigmatism at 6 months, the axis of astigmatism changed from ATR to WTR in 11 eyes (12.4%) and from WTR to ATR in 27 eyes (30.3%). Of the 89 eyes, the axis changed in more eyes with WTR astigmatism preoperatively (27 of 53; 50.9%) than eyes with ATR astigmatism preoperatively (11 of 32; 34.1%). The

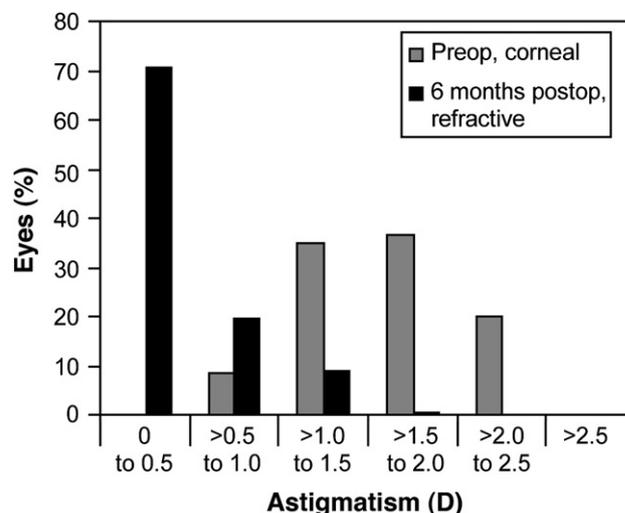


Figure 1. Magnitude of astigmatism in 164 eyes preoperatively and 6 months postoperatively.

difference was not statistically significant ($P = .14$, chi-square analysis). None of the 6 eyes with oblique preoperative astigmatism had an axis change of 90 degrees. The mean axis shift in oblique eyes was 40 ± 20 degrees (maximum 67 degrees).

Refractive Predictability and Stability

Of the 168 eyes with targets noted and with a complete follow-up, the SE at 6 months was within ± 0.50 D of the intended value in 112 eyes (77.2%) and within ± 1.00 D of the intended value in 134 eyes (92.4%). All eyes were within ± 2.00 D of the intended SE. The mean change in SE was -0.1 ± 0.4 D from 1 month to 3 months postoperatively ($n = 173$), 0.0 ± 0.4 D from 3 months to 6 months ($n = 146$), and -0.1 ± 0.4 from 1 month to 6 months ($n = 155$).

Visual Acuity

Preoperatively, the mean binocular UDVA was 0.7 ± 0.6 logMAR ($n = 70$) and the mean binocular CDVA, 0.3 ± 0.3 logMAR ($n = 84$). The mean binocular UDVA was 0.06 ± 0.12 logMAR 1 month postoperatively, 0.05 ± 0.11 logMAR at 3 months, and 0.05 ± 0.11 logMAR at 6 months. Figure 2 shows the distribution of Snellen-equivalent visual acuity. Of the 100 patients assessed 1 month postoperatively, 97 (97.0%) had a binocular UDVA of 20/40 or better and 60 (60.0%), of 20/20 or better. Of the 78 patients assessed at 6 months, 77 (98.7%) had a binocular UDVA of 20/40 or better and 49 (62.8%), of 20/20 or better. The improvement in UDVA from preoperatively to postoperatively was statistically significant ($P < .001$). The 1 patient who did not have at least 20/40 UDVA at 6 months had an SE of -0.50 D in both eyes; however, glaucoma with visual function changes was noted at the preoperative assessment.

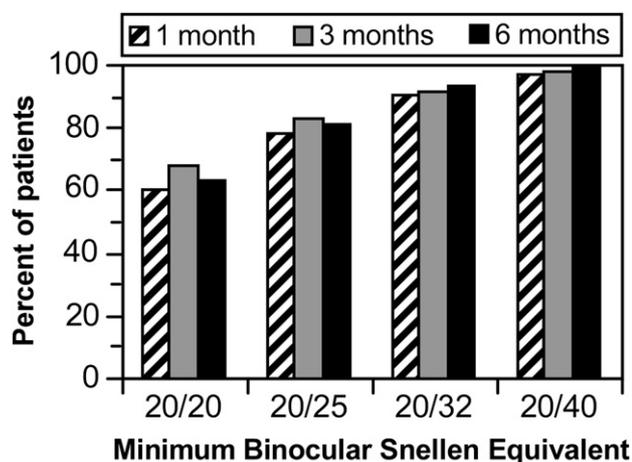


Figure 2. Postoperative binocular Snellen equivalent UDVA at 1 month ($n = 117$), 3 months ($n = 87$), and 6 months ($n = 78$).

Preoperatively, the mean binocular CDVA was 0.30 ± 0.30 logMAR ($n = 84$). The mean binocular CDVA at 6 months was 0.03 ± 0.14 logMAR ($n = 71$). The improvement in CDVA from preoperatively to postoperatively was statistically significant ($P < .001$).

Rotational Stability

Table 2 shows the rotational stability of the toric IOLs. Of the 161 IOLs assessed 6 months postoperatively, the operative target axis was on file for 157. Of the 157 IOLs, 143 (91.1%) were within ± 5 degrees of the operative axis and all were within ± 10 degrees. At the last observation of the 217 IOL axes carried forward, 197 IOLs (90.8%) were within ± 5 degrees of the operative axis and 215 IOLs (99.1%) were within ± 10 degrees. The 2 IOLs with more than 10 degrees of rotation at the last observation were rotated 13 degrees and 14 degrees from the operative axis. One IOL was rotated 20 degrees clockwise 1 day postoperatively and 34 degrees from the intended axis at 1 month. The IOL was repositioned before the 3-month assessment. At 6 months, the IOL was within ± 4 degrees of the intended axis.

Subjective Patient Experience

Statistically significantly more patients reported being spectacle independent postoperatively than preoperatively ($P < .001$). Of the 78 patients who completed a subjective questionnaire preoperatively and 6 months postoperatively, 54 (69.2%) did not require spectacles at all or never used spectacles for distance vision (Figure 3). At 6 months, 77 patients provided satisfaction ratings. Of those, 56 patients (72.7%) rated their postoperative satisfaction as 9 or 10 and 72 patients (93.5%), as 7 or higher (Figure 4). Patient satisfaction was statistically significantly higher at 6 months than at baseline ($P < .001$, paired t test). For patients with financial records on file, satisfaction at 6 months was statistically similar ($P = .52$) between those who received the IOLs for free (mean 8.8 ± 1.7 ; $n = 47$) and those who paid the local market rate (mean 9.2 ± 1.0 ; $n = 17$).

At 6 months, 2 patients rated their satisfaction as 4 or lower. One may have misunderstood the rating scale on the questionnaire because the patient did not require spectacles for distance vision, had no halos, had rare to mild glare, and had 20/20 monocular and binocular UDVA. In addition, the patient had rated satisfaction as 10 at the 3-month assessment. The other patient, who rated satisfaction as 4, had mild posterior capsule opacification and posterior vitreous detachment in both eyes. This patient was referred to a retina specialist for flashes and floaters and was scheduled for capsulotomy.

Table 2. Rotational stability of the toric IOLs.

Parameter	Postoperative Assessment				
	1 D	1 Mo	3 Mo	6 Mo	Last Carried Forward*
Mean degrees from operative axis	2 ± 3	2 ± 4	2 ± 3	2 ± 2	2 ± 3
Mean degrees from 1-day postop axis	—	2 ± 4	1 ± 2	1 ± 2	2 ± 4
Intraocular lenses assessed (n)	212	217	188	161	217

Means ± SD
*Last postoperative observation for each eye was carried forward and then final results were averaged.

Patients reported a statistically significant reduction in the frequency and severity of halos and glare from preoperatively to postoperatively ($P < .05$) (Table 3). Six months postoperatively, 48 patients (61.5%) reported never seeing halos and no patient reported severe halos. The 5 patients who reported moderate halos rated their satisfaction as 7 or higher. Thirty-five patients (44.9%) never had glare symptoms, and 23 patients (29.5%) rarely had glare symptoms. The 2 patients who reported severe postoperative glare rated their satisfaction with vision as 10 and had also reported severe glare at intake.

DISCUSSION

In this study of 234 eyes of 117 patients (excluding 3 monocular cases) with a mean preoperative corneal astigmatism of 1.7 ± 0.4 D, apparent astigmatism was reduced to 0.4 ± 0.4 D of refractive cylinder 6 months postoperatively. The mean preoperative astigmatism and the mean postoperative astigmatism were slightly lower than in populations in other studies (Table 4).^{4-7,10} The distribution of residual astigmatism in our study (90% of eyes ≤ 1.0 D) agrees

with the results of Bauer et al.,⁷ who reported a cutoff instead of an average (91% of eyes ≤ 1.0 D).

In our study, the mean residual astigmatism by IOL model was in line with mathematical modeling, which predicted residual astigmatism ranging from 0.2 to 0.4 D when SIA was included in the planning process and from 0.5 to 0.8 D when SIA was not included.⁹ Although more aggressive IOL selection criteria may yield significantly less residual astigmatism,¹¹ our study did not allow deviation from the recommendations of the online toric IOL calculator.

The rotational stability of the toric IOLs in our study compares well with results in the literature (Table 4). The stability of the toric IOL in our large population (91% of IOLs with ≤ 5 degrees rotation) was on a par with that in previous reports of smaller populations with the same toric IOL (77% to 95% within ± 5 degrees).⁴⁻⁶

Few studies report bilateral binocular visual outcomes for the toric IOLs we evaluated. In our study, the mean postoperative binocular UDVA at 6 months was 0.05 ± 0.11 logMAR, with 99% of patients having a UDVA of 20/40 or better and 63% of 20/20 or better. The only bilateral study in Table 4 reported only monocular outcomes for its 15 bilateral patients (0.16 ± 0.18 logMAR, 20/40 or better in 93% of eyes).⁴ The good UDVA in our study resulted in 69% of patients reporting spectacle independence for distance vision.

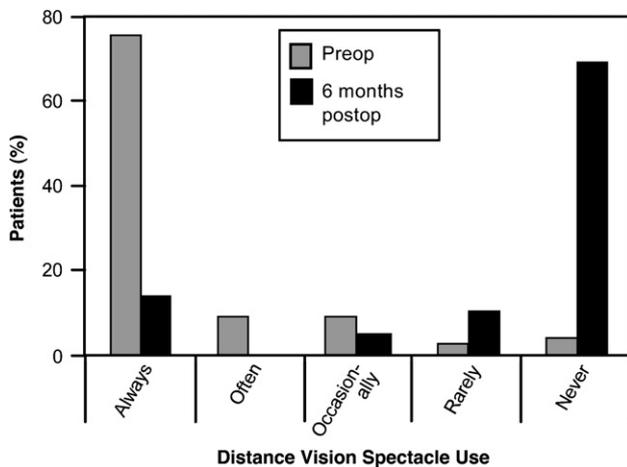


Figure 3. Spectacle use for distance preoperatively and 6 months postoperatively (n = 78).

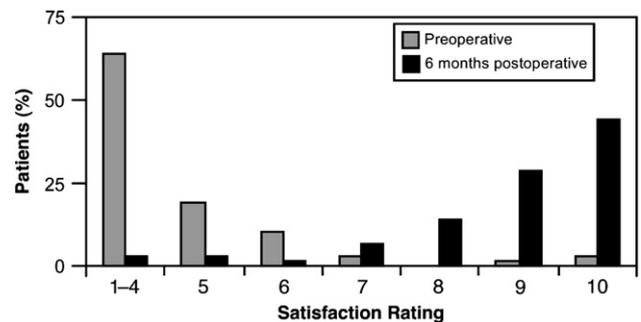


Figure 4. Vision satisfaction ratings preoperatively and 6 months postoperatively (n = 78) (1 = completely unsatisfied; 10 = completely satisfied).

Table 3. Visual disturbances reported by 78 patients preoperatively and 6 months postoperatively.

	Frequency (% of Patients)					Rating (% of Patients)			
	Never	Rarely	Occasionally	Often	Always	None	Mild	Moderate	Severe
Halos									
Preop	42	14	22	9	13	41	20	27	12
6 mo postop	62*	17	19	3	0	64*	29	6	0
Glare									
Preop	24	12	33	18	13	24	27	29	21
6 mo postop	45*	29	15	8	3	53*	34	10	3

* $P < .05$ versus preoperatively ("never" or "none" versus any other response) by chi-square analysis

This result compares well with those in clinical trials of unilateral AcrySof toric IOL implantation, in which 60% of patients were spectacle independent 4 to 6 months after surgery (AcrySof Toric Single-Piece Natural IOL Product Information, Alcon, Inc., 2005).

Bilateral implantation also allowed us to assess visual disturbances without contribution from early cataractous changes in the nonsurgical phakic eye. The frequency and severity of halos and glare were lower 6 months postoperatively than preoperatively. No patient reported severe halos; the 2 patients who reported severe glare also reported severe glare preoperatively. Most patients with glare or halo symptoms rated them as mild.

Photoc phenomena are more commonly associated with multifocal IOLs but also can occur with monofocal IOLs. Halos have been correlated with corneal irregularities and astigmatism greater than 1.00 D in patients with multifocal IOLs, and glare has been correlated with age over 70 years in patients with monofocal IOLs.¹² Patients in our study who reported moderate or severe visual disturbances were still satisfied with their vision. This may be explained by their good postoperative UDVA and reduced dependence on spectacles. Nijkamp et al.¹³ found that distance

vision without glasses was significantly correlated with patient satisfaction after cataract surgery. In a linear stepwise analysis, Walkow et al.¹⁴ found that UDVA was the most influential factor in predicting patient satisfaction after cataract surgery; distance spectacle independence was also correlated with satisfaction, although halos and glare were not.

Most patients in our study did not pay a premium for the toric IOLs. Satisfaction was statistically similar between patients who paid extra and those who did not. Although paying patients rated their satisfaction as high (mean 9.2 ± 1.0 out of 10), the small number of patients in that group ($n = 17$) limits extrapolation of their satisfaction levels to satisfaction in an average paying population. Paying a significant premium might affect satisfaction ratings in cases with suboptimum outcomes, such as when distance spectacles are needed postoperatively. Interpretation of satisfaction levels is also limited by the lack of a control group with non-toric IOLs. Much of the reason for the high postoperative satisfaction score might have been related to improvement in spherical error and a clear lens (ie, cataract removed, IOL in place). The proportion of satisfaction related to the correction of astigmatism is unknown.

Table 4. Comparison of toric IOL studies.

Study*/Year	IOL Type	FU (Mo)	Pt (n)	Eyes (n)	Mean Astigmatism (D) \pm SD		IOL Rotation from Intended Axis (%)	
					Preop	Postop	$\leq 5^\circ$	$\leq 10^\circ$
Present	AcrySof	6	117	234	$1.7 \pm 0.4^\dagger$	0.4 ± 0.4	91	99
Mendicute ¹⁰ /2009	AcrySof	3	20	20	$1.8 \pm 0.7^\dagger$	0.6 ± 0.5	95	100
Bauer ⁷ /2008	AcrySof	4.5	NA	43	$2.1 \pm 0.8^\dagger$	$91\% \leq 1.0$	NA	100
Mendicute ⁴ /2008	AcrySof	3	15	30	$2.3 \pm 1.3^\dagger$	0.7 ± 0.4	77	97
Zuberbuhler ⁵ /2008	AcrySof	3	30	44	1.0 to 5.0^{\ddagger}	NA	95	100
Chang ⁶ /2008	AcrySof	1	-	100	2.5	0.5	90	99

FU = follow-up; IOL = intraocular lens; NA = not available; Pt = patients

*First author

[†]Corneal astigmatism; unmarked values are refractive

[‡]Range

In conclusion, the rotational stability, significant reduction of cylinder, and predictable postoperative SE in our study indicate that bilateral AcrySof toric IOL implantation provides excellent binocular UDVA. Patients in this study, which we believe to be the largest prospective investigation of bilateral implantation of these toric IOLs to date, had excellent postoperative vision and were highly satisfied with their visual results.

REFERENCES

- Hoffer KJ. Biometry of 7,500 cataractous eyes. *Am J Ophthalmol* 1980; 90:360–368; correction, 890
- Shimizu K, Misawa A, Suzuki Y. Toric intraocular lenses: correcting astigmatism while controlling axis shift. *J Cataract Refract Surg* 1994; 20:523–526
- Ma JJK, Tseng SS. Simple method for accurate alignment in toric phakic and aphakic intraocular lens implantation. *J Cataract Refract Surg* 2008; 34:1631–1636
- Mendicute J, Irigoyen C, Aramberri J, Ondarra A, Montés-Micó R. Foldable toric intraocular lens for astigmatism correction in cataract patients. *J Cataract Refract Surg* 2008; 34:601–607
- Zuberbuhler B, Signer T, Gale R, Haefliger E. Rotational stability of the AcrySof SA60TT toric intraocular lenses: a cohort study. *BMC Ophthalmol* 2008; 8:8. Available at: <http://www.biomedcentral.com/content/pdf/1471-2415-8-8.pdf>. Accessed December 8, 2009
- Chang DF. Comparative rotational stability of single-piece open-loop acrylic and plate-haptic silicone toric intraocular lenses. *J Cataract Refract Surg* 2008; 34:1842–1847
- Bauer NJC, de Vries NE, Webers CAB, Hendrikse F, Nuijts RMMA. Astigmatism management in cataract surgery with the AcrySof toric intraocular lens. *J Cataract Refract Surg* 2008; 34:1483–1488
- Javitt JC, Wang F, Trentacost DJ, Rowe M, Tarantino N. Outcomes of cataract extraction with multifocal intraocular lens implantation; functional status and quality of life. *Ophthalmology* 1997; 104:589–599
- Hill W. Expected effects of surgically induced astigmatism on AcrySof toric intraocular lens results. *J Cataract Refract Surg* 2008; 34:364–367
- Mendicute J, Irigoyen C, Ruiz M, Illarramendi I, Ferrer-Blasco T, Montés-Micó R. Toric intraocular lens versus opposite clear corneal incisions to correct astigmatism in eyes having cataract surgery. *J Cataract Refract Surg* 2009; 35:451–458
- Hill WE, Potvin R. Monte Carlo simulation of expected outcomes with the AcrySof® toric intraocular lens Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2586009/pdf/1471-2415-8-22.pdf>. Accessed December 8, 2009
- Dick HB, Krummenauer F, Schwenn O, Krist R, Pfeiffer N. Objective and subjective evaluation of photic phenomena after monofocal and multifocal intraocular lens implantation. *Ophthalmology* 1999; 106:1878–1886
- Nijkamp MD, Dolders MGT, de Brabander J, van den Borne B, Hendrikse F, Nuijts RMMA. Effectiveness of multifocal intraocular lenses to correct presbyopia after cataract surgery; a randomized controlled trial. *Ophthalmology* 2004; 111:1832–1839
- Walkow T, Klemen UM. Patient satisfaction after implantation of diffractive designed multifocal intraocular lenses in dependence on objective parameters. *Graefes Arch Clin Exp Ophthalmol* 2001; 239:683–687



First author:

Iqbal Ike K. Ahmed, MD

*Private practice, Mississauga,
Ontario, Canada*

***Canadian Toric Study Group**

Alberta: Harold Climenhaga, MD, Royal Alexandra Hospital and University of Alberta, Edmonton; Jit Gohill, MD, Surgical Centres Inc. and University of Calgary, Calgary

British Columbia: John Blaylock, MD, Valley Laser Eye Centre , Abbotsford, and Chilliwack General Hospital, Chilliwack; Pierre Faber, MD, Providence Health Care, University of British Columbia, Vancouver; Francis Law, MD, Eye Care Centre, Vancouver General Hospital, University of British Columbia, Vancouver

Manitoba: Guillermo Rocha, MD, Brandon Regional Health Authority, Brandon

Nova Scotia: Daniel Belliveau, MD, Queen Elizabeth II Health Sciences Centre, Victoria General Hospital Site, Halifax

Ontario: Ike Ahmed, MD, Credit Valley Eye Care, Mississauga; Joseph Ma, MD, North York General Hospital and Herzig Eye Institute, Toronto; Allan R. Slomovic, MD, Toronto Western Hospital, University Health Network, Toronto; Raymond Stein, MD, Bochner Eye Institute (Toronto, Ontario) and University of Toronto, Toronto

Quebec: Alain Grégoire, MD, Centre Hospitalier Universitaire de Sherbrooke, Sherbrooke University, Sherbrooke; Dominique Meyer, MD, Institut Privé de Chirurgie Quebec; Michel Podtetenev, MD, Department of Ophthalmology, University of Montreal, Montreal