Resident experience with toric and multifocal intraocular lenses in a public county hospital system

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PURPOSE: To study the outcomes of toric and multifocal intraocular lens (IOL) implantation performed by resident surgeons.

SETTING: Parkland Health and Hospital System, Dallas, Texas, USA.

DESIGN: Case series.

METHODS: Patients seen between July 2008 and May 2011 and meeting inclusion criteria (including >1.0 diopter [D] of astigmatism in toric group and <0.75 D astigmatism in multifocal group) were offered implantation of the study IOLs. Major outcomes were uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) and, for the multifocal IOL, near visual acuity. Residents were surveyed about their knowledge regarding these IOLs.

RESULTS: Seventy-nine eyes of 60 patients received an Alcon Acrysof toric IOL. Eighteen eyes of 10 patients received an Alcon Acrysof Restor IOL. In the toric group, 57% of eyes achieved a postoperative UDVA of 20/25 or better and 90% achieved 20/40 or better. The CDVA was 20/25 or better in 92% of eyes. The mean refractive cylinder was 1.69 D preoperatively and 0.38 D postoperatively. In the multifocal group, 78% of patients achieved a UDVA of 20/25 or better and 94% achieved 20/40 or better. All patients had a CDVA of 20/25 or better. Near vision was Jaeger 3 or better in 94%. The survey showed that residents have a strong comfort level with preoperative and surgical techniques for premium IOLs after their experience in the residency setting.

CONCLUSION: Residents in public county hospitals can be taught to use premium IOLs with good success rates, comparable to those in other published studies.

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An important and rapidly growing component of modern cataract surgery involves the use of advanced-technology intraocular lenses (IOLs), which include toric and multifocal platforms. Toric IOLs allow the correction of corneal astigmatism. Multifocal IOLs provide good vision at a larger range of distances than standard IOLs, improving near and distance vision simultaneously. These premium IOLs give patients a greater degree of spectacle independence after cataract surgery, which is an ever-increasing demand in the patient population.

Each type of premium IOL requires the surgeon to be familiar with different surgical techniques as well as certain unique aspects of preoperative and postoperative management and patient education. It is important that current resident education incorporate the use of toric and multifocal IOLs so that residents have a better transition to their own practices and offer their patients a wide range of choices for cataract surgery.

PATIENTS AND METHODS

The study was approved by the Institutional Review Board, University of Texas Southwestern Medical Center. Cataract surgery patients seen at Parkland Health and Hospital System, the public hospital system for Dallas County, Texas, who met inclusion criteria were offered implantation of a study IOL. Patients with more than 1.00 diopter (D)

of astigmatism were eligible to receive the toric IOL. Patients had to have less than 0.75 D of astigmatism on keratometry and/or topography and to have axial length (AL) measurements obtained by optical coherence biometry to be eligible to receive the apodized diffractive multifocal IOL.

Preoperatively, informed consent was obtained and patients received a complete ophthalmic examination including slitlamp evaluation, tonometry, visual acuity, refraction, keratometry, biometry, topography, and dilated fundus evaluation. Patients with corneal surface abnormalities, irregular astigmatism, and retinal pathology on preoperative examination were excluded.

All surgery was performed by third-year residents via phacoemulsification using a 3.0 mm incision.

In the toric cases, the Acrysof toric IOL (Alcon Laboratories, Inc.) was implanted. The Acrysof toric online calculator[A] was used to determine the correct lens platform as follows: T3 (correcting 1.50 D at the IOL plane), T4 (2.25 D), or T5 (3.00 D). The steep and flat keratometry readings were placed into the calculator, and 0.40 D of the anticipated surgically induced astigmatism for a 3.0 mm incision was entered. The placement of the main incision was varied to give the most desirable anticipated residual astigmatism. Cases with a marked discrepancy between cylinder and axis on IOLMaster optical biometry (Carl Zeiss Meditec AG) and Atlas topography (Carl Zeiss Meditec AG) did not receive toric IOLs. Refraction was not used as a determinant of cylinder axis because of the presence of lenticular astigmatism in some cases as well as unreliable refraction in some cases resulting from dense cataract. Intraocular lens spherical power was determined using the SRK/T formula. The targeted spherical outcome was plano to −0.50 D. The preoperative corneal markings were made with the patients sitting upright to negate possible cyclotorsion in the supine position. Residents were instructed how to carefully make preoperative markings to minimize head tilt. An intraoperative toric axis marker or preoperative marks made at the slitlamp were used to determine actual axis placement. The surgeries were performed by senior residents who were completing their surgical chief rotation. After injection, all IOLs were rotated approximately 15 degrees from the intended axis and the ophthalmic viscosurgical device was removed. The IOLs were then rotated to their final position to coincide with the corneal axis markings. Initially, the nonaspheric Acrysof toric IOLs were used; however, aspheric Acrysof toric IOLs were used once they became commercially available.

Multifocal IOL patients had placement of an Alcon Acrysof Restor SN6AD1 or SN6AD3 IOL. The IOL spherical power was determined using the SRK/T formula with a target refraction of +0.25 D for the SN6AD3 model and plano for the SN6AD1 model.

Major outcomes were uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) and, for the multifocal IOL, uncorrected near visual acuity (UNVA).

Residents were given a questionnaire after completion of their surgical chief rotation. They were asked to respond to various questions and rate their responses using a 5-point Likert scale. As part of the residency curriculum, residents received an annual course on astigmatism correction in the cataract patient and the use of multifocal IOLs, detailing the procedures at Parkland Health and Hospital System as well as the importance of preoperative and postoperative patient counseling and exact preoperative examination and measurements.

The surgeries were videotaped. Complicated procedures were discussed at a monthly conference, and the residents' best cases were reviewed 1-on-1 with faculty.

RESULTS

Toric Group

The toric IOL group comprised 85 eyes of 64 patients with more than 1.00 D of corneal astigmatism. Three eyes that received toric IOLs but had less than 1 week of follow-up postoperatively were excluded from the analysis. One eye with 1 week of follow-up was excluded due to lack of recorded refraction, and 1 eye was excluded because of high corneal cylinder (>5.50 D). Another was excluded due to amblyopia and inability to obtain reliable postoperative refraction. This patient had a dense posterior subcapsular cataract and high corneal cylinder (5.52 D), making the visual potential unclear on preoperative examination. Three eyes also received concurrent limbal relaxing incisions for corneal astigmatism that was significantly greater than that correctable by the T5 model, although 1 patient was excluded due to amblyopia, as stated above. Limbal relaxing incisions were performed just before cataract surgery and by residents with previous experience as a primary surgeon in at least 60 cataract extractions. Two eyes were scheduled to receive advanced-technology IOLs; however, because of capsule breaks, they received conventional IOLs.

Final analysis of the toric IOL group comprised 79 eyes of 60 patients. Of the eyes, 30 received a nonaspheric model and 49 eyes the aspheric model.

The mean age in the toric IOL group was 57.6 years ± 14.4 (SD) (range 22 to 88 years); 41 patients (68%) were women. The mean follow-up was 3.9 ± 4.4 months (range 1 week to 17 months). The mean AL in the toric group was 23.98 ± 1.13 mm (range

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Table 1. Preoperative astigmatism and postoperative refractive outcomes in the toric group.

	Preoperative Cylinder (D)			Postoperative (D)	
IOL Model	Optical Coherence Biometry	Topography	Refractive	Refractive Cylinder	SE
T3 (13 eyes)					
Mean ± SD	1.31 ± 0.30	1.30 ± 0.34	1.37 ± 0.86	0.19 ± 0.20	−0.35 ± 0.32
Range	0.91, 1.92	0.75, 2.00	0.00, 2.75	0.00, 0.50	−1.00, +0.125
T4 (26 eyes)					
Mean ± SD	1.64 ± 0.38	1.79 ± 0.68	1.22 ± 0.76	0.39 ± 0.49	−0.42 ± 0.60
Range	0.79, 2.39	1.12, 4.00	0.00, 3.00	0.00, 1.75	−2.50, +0.625
T5 (40 eyes)					
Mean ± SD	2.71 ± 0.88	2.68 ± 0.93	2.14 ± 1.29	0.44 ± 0.43	−0.35 ± 0.49
Range	1.47, 5.44	1.38, 5.13	0.00, 7.50	0.00, 1.50	−1.75, +1.00
All (79 eyes)					
Mean ± SD	2.13 ± 0.90	2.16 ± 0.95	1.69 ± 1.17	0.38 ± 0.43	−0.37 ± 0.51
Range	0.79, 5.44	0.75, 5.13	0 .00, 7.50	0.00, 1.75	−2.50, +1.00

IOL = intraocular lens; SE = spherical equivalent

21.24 to 26.37 mm), and the mean IOL spherical power was 19.6 ± 3.2 D (range 11.5 to 26.5 D).

Table 1 and Figure 1 show the preoperative astigmatism in the toric group; Table 1 also shows the postoperative refractive outcomes. After surgery, the mean refractive cylinder decreased in all eyes.

Table 2 shows the postoperative visual acuity in the toric group. The UDVA was 20/25 or better in 45 eyes (57%) and 20/40 or better in 71 eyes (90%). The CDVA was 20/25 or better in 73 eyes (92%). Outliers with limited corrected vision included 4 patients who had visually significant diabetic retinopathy, 1 patient who had dry age-related macular degeneration, and 1 patient with persistent anterior chamber reaction at the 1-month follow-up visit. Preoperative refraction was unreliable in 6 patients because of dense cataract.

Three patients in the toric group had IOL rotation postoperatively. One IOL rotated 7 degrees, and the patient had 1.00 D of cylinder postoperatively. Another rotated 5 degrees with 1.25 D of residual cylinder, and a third rotated 3 degrees with 0.75 D of residual cylinder.

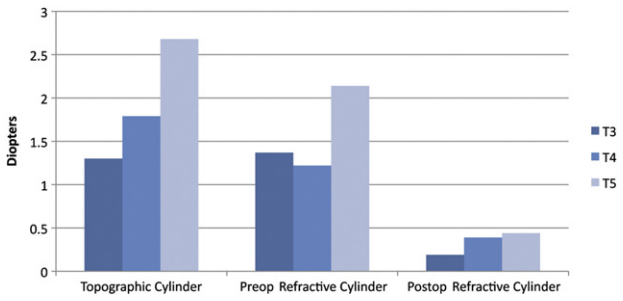

Figure 1. Preoperative and postoperative astigmatism in the toric group (T3, T4, and T5 = toric IOL models used in study).

Multifocal Group

The multifocal group consisted of 18 eyes of 10 patients who requested correction of both near and distance vision. The mean age of the patients was 66.8 ± 8.1 years (range 53 to 80 years); 5 patients (50%) were women. The mean follow-up was 1.7 ± 1.3 months (range 1 week to 4 months). Eight eyes received the SN6AD3 model, and 10 eyes received the SN6AD1 model. Table 3 shows the preoperative data.

Table 4 shows the postoperative visual acuity in the multifocal group. The UDVA was 20/25 or better in 14 eyes (78%) and 20/40 or better in 17 eyes (94%). The UNVA was Jaeger (J) 1 or better in 8 eyes (44%) and J3 or better in 17 eyes (94%). The CDVA was 20/25 or better in all eyes.

One IOL was explanted due to dislocation and was replaced with a 3-piece Acrysof Restor MN60D3 IOL (Alcon Laboratories, Inc.) placed in the ciliary sulcus. This patient's UDVA was 20/70 with 1.00 D of cylinder postoperatively. Two eyes in the SN6AD1 group had a UDVA of 20/40, 1 due to a postoperative refraction of −1.00 D sphere and another due to residual cylinder of 1.00 D. One eye in the SN6AD3 group had a UDVA of 20/40 due to mild myopia with 0.50 D of astigmatism (Table 5).

Twenty-four residents performed the surgeries, and 19 residents completed the post-rotation survey. The mean ratings of resident knowledge about premium IOLs and their impact on residents' future practice

Table 2. Visual outcomes in the toric group.

	UDVA, n (%)			CDVA, n (%)	
IOL Model	20/20–20/25	20/30–20/40	<20/40	20/20–20/25	<20/25
T3	10 (76.9)	2 (15.4)	1 (7.7)	13 (100)	0
T4	14 (53.8)	9 (32.6)	3 (11.5)	23 (88.5)	3 (11.5)
T5	21 (52.5)	15 (37.5)	4 (10.0)	37 (92.5)	3 (7.5)
All	45 (57.0)	26 (32.9)	8 (10.1)	73 (92.4)	6 (7.6)

CDVA = corrected distance visual acuity; IOL = intraocular lens; UDVA = uncorrected distance visual acuity

were all above 4 on a scale from 1 to 5 (1 = lowest; 5 = highest) (Table 6).

DISCUSSION

Toric IOLs allow the surgeon to correct astigmatism intraoperatively using the IOL platform, thereby improving postoperative refractive results. In our study, 90% of patients receiving toric IOLs by resident surgeons had a UDVA of 20/40 or better. Refractive cylinder decreased from a mean of 1.69 D preoperatively to 0.38 D postoperatively. Seventy-five percent of all eyes had a residual cylinder of 0.50 D or less, while 85% achieved a residual cylinder of 0.75 D or less. In several eyes, the CDVA was limited due to ocular comorbidities, including retinal pathology such as diabetic retinopathy and macular degeneration. Residual cylinder was highest with the toric T5 IOL model; this may be related to the inclusion of several eyes in the study with more than 2.06 D of corneal astigmatism, which is the correction of the T5 IOL at the corneal plane.

The results in our study are similar to those in previously published studies of Acrysof toric IOLs implanted by experienced surgeons. Mendicute et al.[1] found a mean residual cylinder of 0.72 D with a UDVA of 20/40 or better in 93% of eyes, while Bauer et al.[2] found that 90% of patients had a UDVA of 20/40 or better and 74% had residual cylinder less than 0.75 D. Dardzhikova et al.[3] report a mean residual cylinder of 0.32 D with the Acrysof toric IOL, while Lane et al.[4] found that 60% of patients had residual cylinder of 0.50 D or less. Holland et al.[5] report a mean postoperative cylinder of 0.59 D in patients receiving toric IOLs, with a UDVA of 20/25 or better in 63% of eyes and 20/40 or better in 92% of eyes. In our study, the outcomes of surgery performed by residents at a public county hospital are consistent with, and in some cases better than, results in these previous studies. There was little postoperative IOL rotation in our study, with only 1 patient having rotation greater than 5 degrees. However, the limited length of follow-up in this study may have led to underestimation of postoperative IOL rotation. Acrysof toric IOLs have been found to have excellent rotational stability, with a mean lens rotation less than 4 degrees from the initial placement 6 months after surgery.[6] The ability to correct astigmatism and decrease need for prescription glasses may be particularly important in an indigent population. Pineda et al.[7] have shown that toric IOLs reduce lifetime economic costs by reducing the need for glasses or contact lenses after cataract removal.

Table 3. Preoperative data in the multifocal group.

	Cylinder (D)			
IOL Model	Refractive	Optical Coherence Biometry	Topography	AL (mm)
SN6AD1 (10 eyes)				
Mean ± SD	0.62 ± 0.62	0.39 ± 0.17	0.41 ± 0.24	23.28 ± 0.56
Range	0.00, 2.00	0.17, 0.75	0.00, 0.75	22.57, 24.31
SN6AD3 (8 eyes)				
Mean ± SD	0.53 ± 0.47	0.53 ± 0.45	0.35 ± 0.34	23.85 ± 0.47
Range	0.00, 1.5	0.00, 1.26	0.12, 1.00	23.18, 24.57
All (18 eyes)				
Mean ± SD	0.71 ± 0.58	0.45 ± 0.33	0.39 ± 0.29	23.53 ± 0.60
Range	0.00, 2.00	0.00, 1.26	0.00, 1.00	22.57, 24.57

AL = axial length; IOL = intraocular lens

Table 4. Postoperative visual outcomes in multifocal group.

	Number (%)					
	UDVA			CDVA	UNVA	
IOL Model	20/20–20/25	20/30–20/40	<20/40	20/20–20/25	J1 or Better	J3 or Better
SN6AD1	8 (80.0)	2 (20.0)	0	10 (100)	2 (20)	10 (100)
SN6AD3	6 (75.0)	1 (12.5)	1 (12.5)	8 (100)	6 (75)	7 (87.5)
All	14 (77.8)	3 (16.7)	1 (5.6)	18 (100)	8 (44.4)	17 (94.4)

CDVA = corrected distance visual acuity; IOL = intraocular lens; UDVA = uncorrected distance visual acuity; UNVA = uncorrected near visual acuity

Compared with traditional IOLs, multifocal IOLs allow patients to see better at near as well as distance after cataract surgery. In the multifocal group, 78% of eyes achieved a UDVA of 20/25 or better and 94% had a UDVA of 20/40 or better. The only patient who had a UDVA worse than 20/40 had explantation of a dislocated SN6AD3 IOL and placement of a 3-piece Acrysof Restor IOL in the ciliary sulcus. All eyes achieved a CDVA of 20/25 or better, and the UNVA was J1 or better in 44% of eyes and J3 or better in 94%. These results compare favorably with those in previous studies of multifocal IOLs implanted by experienced surgeons. In a study by Souza et al.,[8] patients had a mean UDVA of 0.06 logMAR and a mean CDVA of 0.02 logMAR. The mean postoperative UNVA was 0.16 logMAR units. Chiam et al.[9] found that 93.8% of patients in a multifocal group achieved a UDVA of 20/30 or better and 75% achieved a UNVA of 20/30 or better. In a study by de Vries et al.,[10] the mean UDVA postoperatively was 0.05 logMAR and the mean UNVA, 0.01 logMAR. In a metaanalysis, Cochener et al.[11] found that the mean visual acuity for Acrysof Restor IOLs was 0.067 logMAR at distance and 0.064 logMAR at near. These results show that the mean UDVA in most cases is between 20/20 and 20/25, consistent with findings in our study. The outcomes for near vision in our study are slightly worse than those in the de Vries et al. study[10] but more consistent with those in Souza et al.'s study,[8] with the mean UNVA between 20/25 and 20/30. The relatively short follow-up in this study may have introduced a source of error in the measurement of final visual outcomes.

Advanced-technology IOLs are being implanted in an increasing number of patients having cataract surgery. Our survey found that residents strongly believe these IOLs will be used frequently in their future practices and that experience during residency gives them a strong working knowledge of the preoperative evaluation and surgical technique for these patients. The use of these IOLs during residency is important because it provides the opportunity to learn the preoperative, intraoperative, and postoperative management associated with these new technologies. It helps prepare residents for the future by teaching them the technical components of surgery and helping them gain valuable experience in counseling patients about options regarding cataract surgery. Advanced-technology IOLs are an important component of

Table 5. Postoperative refractive outcomes and mean spherical power of implanted IOLs in the multifocal group.

IOL Model	SE (D)	Refractive Cylinder (D)	Mean IOL Power (D)
SN6AD1			
Mean ± SD	−0.20 ± 0.29	0.30 ± 0.40	21.20 ± 1.42
Range	−1.00, 0.00	0.00, 1.00	18.50, 22.50
SN6AD3			
Mean ± SD	0.13 ± 0.40	0.38 ± 0.33	20.06 ± 1.94
Range	−0.50, 0.875	0.00, 1.00	17.50, 23.00
All			
Mean ± SD	−0.06 ± 0.38	0.33 ± 0.37	20.69 ± 1.76
Range	−1.00, 0.875	0.00, 1.00	17.50, 23.00

IOL = intraocular lens; SE = spherical equivalent

Table 6. Results of the post-rotation resident survey.

Item	Mean Rating*
Knowledge of preoperative workup for multifocal IOLs	4.42
Knowledge of preoperative workup for toric IOLs	4.74
Knowledge of surgical techniques for multifocal IOLs	4.79
Knowledge of surgical techniques for toric IOLs	4.74
Degree that premium IOLs will impact your future practice	4.33
Will you personally utilize premium IOLs in future?	4.41
Did this experience better prepare you for using premium IOLs in your future practice?	4.88
To what degree do you feel these lenses will provide spectacle independence for your patients?	4.22

*1 (lowest) to 5 (highest)

modern ophthalmology practice. Residents can be taught to use toric and multifocal IOLs during their training at a public county hospital with outcomes comparable to those in other published studies.

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