Comparison of Refractive Stability After Non-toric Versus Toric Intraocular Lens Implantation During Cataract Surgery

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• PURPOSE: **To compare refractive state changes in eyes implanted with toric intraocular lenses (IOLs) vs non-toric IOLs, after cataract extraction.**
• DESIGN: **Retrospective, comparative.**
• METHODS: **In a single institution, 121 eyes underwent phacoemulsification and implantation with either non-toric IOLs or toric IOLs. The spherical value, cylindrical value, spherical equivalent (SE) of refractive error, and visual acuity were measured preoperatively and 1, 3, and 6 months after surgery. Main outcome measures were the pattern of changes of spherical, cylindrical, and SE values based on postoperative time, between different IOL types.**
• RESULTS: **The groups, which included patients who underwent surgery with SN60WF (Group I), SA6AT3 (Group II-3), SA6AT4 (Group II-4), and SA6AT5 lenses (Group II-5), contained 37, 29, 23, and 32 eyes, respectively. The cylindrical value was significantly decreased in all groups ($P < .05$). Before surgery, the SE of refractive errors was estimated as −0.21, −0.10, −0.20, and −0.22 in the respective groups. The actual remaining SE values were −0.19, −0.24, −0.42, and −0.56 at 1 month; −0.17, −0.26, −0.57, and −0.64 at 3 months; and −0.17, −0.26, −0.70, and −0.74 at 6 months postoperatively, respectively. The follow-up SE values in groups I and II-3 were similar ($P > .05$ in both groups); however, significant myopic changes were observed in Groups II-4 and II-5 after surgery, vs Group I ($P < .05$).**
• CONCLUSION: **Selection of toric IOLs for cataract surgery requires a refined formula to precisely determine necessary IOL power, especially in cases with high levels of astigmatism, to reliably and accurately prevent myopic outcomes. (Am J Ophthalmol 2014;157:658–665.**
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MODERN CATARACT SURGERY HAS CHANGED from the simple surgical removal of lens opacity to providing patients the best possible vision. Also, modern cataract surgery employs concepts of refractive surgery that can render patients free from glasses or contact lenses.[1,2]

Based on 1 report, 36.04% of 23 239 cataract eyes had astigmatism greater than 1 diopter (D), 8.09% were >2 D, and 2.65% were >3 D.[3] Patients who had a high degree of corneal astigmatism before cataract surgery needed glasses or contact lenses after surgery. For precise axial length measurement, appropriate intraocular lens (IOL) power calculation using appropriate specific formulas has been developed.[4] Also, various surgical techniques including small corneal incisions, foldable IOLs, and advanced phacoemulsification devices have been developed for minimizing surgically induced astigmatism.[5–7] Although these methods can minimize surgically induced astigmatism, they do not effectively correct high degrees of preexisting astigmatism.[8] To overcome this limitation, toric IOLs were developed to precisely correct astigmatism.[9]

For determining toric IOL power, the eye is examined and the proper IOL power is calculated using IOLMaster and A-scan parameters. Toricity (cylindrical power) of the toric lens alignment axis is calculated using a program available from the IOL manufacturer, using keratometry values measured by manual keratometry, IOLMaster, automated keratometry, or several kinds of corneal topographic analyses. Therefore, no consideration exists regarding the interaction between astigmatism correction and IOL lens power determination except for the specialized design for refractive adjustment of toric IOLs.

Recently, investigators found that the refractive status of patients who received cataract extraction surgery with toric IOL implantation show greater myopia than expected preoperatively. Despite advanced techniques for analyzing corneal astigmatism and IOL power calculation, refractive power estimation for toric IOLs remains inaccurate. Therefore, we investigated the differences between the predicted spherical equivalent and the actual remnant spherical equivalent in patients who underwent cataract surgery with non-toric IOL vs toric IOL implantation.

METHODS

• PATIENTS: This retrospective case-control study included a total of 121 eyes that underwent phacoemulsification and implantation with either a non-toric IOL

Accepted for publication Dec 2, 2013.
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0002-9394/$36.00
http://dx.doi.org/10.1016/j.ajo.2013.12.003

TABLE 1. Demographics With Preoperative and Postoperative Mean Corneal Astigmatism, Spherical Error, Cylindrical Error, Spherical Equivalents, and Best-Corrected Visual Acuity in Non-toric and Toric Intraocular Lens Implantation

	IOL Type				
	Group I	Group II-3	Group II-4	Group II-5	Total
Lens type	SN60WF	SA6AT3	SA6AT4	SA6AT5	
Number of eyes	37	29	23	32	121
Demographics					
Female, %	62.2	55.2	52.2	62.5	58.7
Mean age, y	66.8	67.3	64.3	61.9	65.2
Left eye, %	54.1	31.0	43.5	62.5	48.8
Goal diopter (D)[a]	−0.21	−0.10	−0.20	−0.22	−0.19
Preoperative					
Flat K (D)	42.76	43.61	43.01	43.05	43.17
Steep K (D)	43.68	45.24	45.03	45.74	44.91
Corneal astigmatism (D)	0.92	1.63	2.01	2.69	1.74
Ocular spherical error (D)	−0.54	0.38	−3.21	−1.11	−0.98
Ocular cylinder error (D)	−1.20	−1.78	−2.75	−2.93	−2.09
Axis (°)	105	87	88	119	101
Spherical equivalents (D)[b]	−1.14	−0.51	−4.59	−2.58	−2.03
BCVA (logMAR)	0.3	0.3	0.4	0.3	0.3
1 month postoperative					
Flat K (D)	42.87	43.67	43.10	43.18	43.25
Steep K (D)	43.68	45.00	44.74	45.69	44.81
Corneal astigmatism (D)	0.81	1.33	1.64	2.51	1.56
Ocular spherical error (D)	0.16	0.15	0.01	−0.04	0.08
Ocular cylinder error (D)	−0.71	−0.79	−0.86	−1.03	−0.84
Axis (°)	89	80	100	61	82
Spherical equivalents (D)[b]	−0.19	−0.24	−0.42	−0.56	−0.34
Deviation from the anticipated spherical equivalent	0.02	−0.14	−0.22	−0.34	−0.15
BCVA (logMAR)	0.0	0.1	0.1	0.1	0.1
3 months postoperative					
Flat K (D)	43.02	44.10	43.10	43.35	43.40
Steep K (D)	43.89	45.35	44.87	45.88	44.70
Corneal astigmatism (D)	0.87	1.25	1.77	2.53	1.30
Ocular spherical error (D)	0.22	0.07	−0.12	−0.14	0.02
Ocular cylinder error (D)	−0.77	−0.68	−0.91	−1.00	−0.83
Axis (°)	93	83	88	76	85
Spherical equivalents (D)[b]	−0.17	−0.26	−0.57	−0.64	−0.39
Deviation from the anticipated spherical equivalent	0.04	−0.16	−0.37	−0.42	−0.20
BCVA (logMAR)	0.0	0.1	0.1	0.0	0.1
6 months postoperative					
Patients retained, n	30	16	17	25	88
Flat K (D)	42.92	44.09	43.24	43.11	43.20
Steep K (D)	43.72	45.52	44.87	45.72	44.82
Corneal astigmatism (D)	0.80	1.43	1.63	2.61	1.62
Ocular spherical error (D)	0.21	0.13	−0.27	−0.17	0.00
Ocular cylinder error (D)	−0.77	−0.78	−0.86	−1.15	−0.90
Axis (°)	97	94	82	65	84
Spherical equivalents (D)[b]	−0.17	−0.26	−0.70	−0.74	−0.45
Deviation from the anticipated spherical equivalent	0.01	−0.16	−0.52	−0.50	−0.26
BCVA (logMAR)	0.0	0.0	0.1	0.0	0.0

BCVA = best-corrected visual acuity; IOL = intraocular lens.

[a]Biometry was performed with optical coherence biometry (IOLMaster; Carl Zeiss Meditec, Dublin, California, USA) using the SRK-T formula for the IOL power calculation. The target postoperative spherical equivalent was the nearest negative emmetropic value.

[b]Spherical error + cylindrical error/2.

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