Comparison of Visual Outcomes for Aspheric and Spherical Toric Intraocular Lens Implantation in Cataract Patients with Pre-Existing Corneal Astigmatism: A Randomized Control Trial

Pichit Naripthaphan MD*,
Pongsak Pachimkul MD*, Somporn Chantra MD*

** Department of Ophthalmology, Rajavithi Hospital, College of Medicine, Rangsit University, Bangkok, Thailand*

Background: *With spherical intraocular lens (IOL) implantation, unaided vision of cataract patients with pre-existing corneal astigmatism is unsatisfactory because astigmatic spectacles will always be needed for clear vision. Toric IOL has been proven to be a major improvement in cataract surgery for spectacle independence. Aspheric property, reported to improve visual quality in a non-toric IOL, has now been added to toric IOL for even better unaided vision.*
Objective: *To compare visual and aberrometric outcomes of 2 toric IOL, spherical and aspheric, at 3 months after implantation.*
Material and Method: *Cataract surgery was performed in cataract patients with pre-existing corneal astigmatism using 2 types of toric IOLs, a spherical toric IOL, Acrys of SN60T, (Group A) and a aspheric toric IOL, Acrts of SN6AT, (Group B) as a randomized control trial. The uncorrected distance (UDVA) and corrected (CDVA) distance visual acuities, residual astigmatism, spherical equivalent (SE) and spherical aberration were evaluated 3 months after implantation.*
Results: *The present study included 44 eyes. No statistically significant difference was found in UDVA, CDVA and residual astigmatism between both groups. The UDVA of 0.1 logMAR or better was found in 78.26% in Group A and 85.71% in Group B. In Group A, 78.26% of eyes and in Group B, 76.19% had a refractive astigmatism value within 0.50 diopter at KP90 (polar value along the 90-degree meridian). The spherical equivalent (SE) was within $\pm$0.5 diopter of emmetropia in 91.30% in Group A and in 80.95% in Group B. Group B had significantly lower spherical aberration Z (4, 0) than Group A.*
Conclusion: *Both groups had similar clinical effectiveness for unaided visual acuity, aided visual acuity and astigmatism correction. Group B had significantly less spherical aberration induction when compared with Group A.*

Keywords: *ToricIOL, Cataract surgery, Astigmatism correction*

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Cataract surgery is the most common surgical procedure performed in medicine. People born in the baby boomer era have reached a cataract us age. Satisfactory results have been achieved with surgical procedures such as extra capsular cataract extraction with IOL implantation. However, many patients still need spectacles after surgery due to residual refractive errors in particular astigmatisms. Advanced developments in technology have not only made cataract surgery become a minimally invasive procedure but also maximized the visual outcomes significantly to be spectacle independent by addressing both spherical and astigmatic components simultaneously. Approximately 50% of the population older than 60 years in United States is estimated to have an astigmatism more than 1.00 diopter (D)[1] and up to 22% of cataract surgery candidates have pre-existing astigmatisms exceeding 1.50 D[2] that need to be corrected or minimized during or after surgery.

Astigmatism correction can be conducted either during cataract surgery by incisional techniques, such as astigmatic keratotomy, limbal relaxing incisions or by implanting a toric intraocular lens (IOL), providing better accuracy. Implantation of toric IOL at the time of cataract surgery has been reported to be safe, effective and predictable[3-5], even in cases of high astigmatism[6] or some diseases related to high astigmatism such as keratoconus, pellucid marginal degeneration, megalocornea and postkeratoplasty astigmatism[7-10]. Also reported in conjunction with toric IOL

Correspondence to:
Naripthaphan P, Department of Ophthalmology, Rajavithi Hospital, 2 Phayathai Road, Ratchathewi, Bangkok 10400, Thailand.
Phone: 0-2644-7000 ext. 2221
E-mail: npichit@hotmail.com

implantation are procedures of limbal relaxing incisions, descemet-stripping automated endothelial keratoplasty, vitreoretinal surgery and touch up with another toric or non-toric IOL as a piggyback[11-14]. The accuracy of pre-operative toric IOL calculation, precise intraoperative placement and long-term rotational stability are critical in achieving good outcomes. The previous type of first generation toric IOL has been reported for rotational stability problems[15,16]. With modern type and design, rotational stability seems to be a minimal problem at present.

To date, two models of most implanted toric IOLs have been used by the authors, the original spherical toric IOL, Acrys of Toric SN60T IOL (Alcon Laboratories, Inc.) and the newly introduced aspherictoric IOL, Acrys of IQ SN6AT IOL (Alcon Laboratories, Inc.). The original Acrys of Toric SN60T IOL platform has been proven as a reliable and predictable toric IOL with efficacy and rotational stability[17,18]. However, limited data exists on the new aspheric model. The main purpose of this study was to compare the refractive and aberrometric results after implantation of these two IOLs.

Material and Method

The protocol of this research was reviewed and approved by the ethics committee of Rajavithi Hospital (No. 129/2556).

Pre-existing corneal astigmatic patients having cataract surgery with toric IOL implantation in the capsular bag were included in this prospective randomized study. The target population was consecutively enrolled beginning in September 2013 and defined according to specific inclusion criteria. An informed consent form in accordance with the Helsinki Declaration was obtained for randomization. As a randomized control trial, patients were informed that the IOL type implanted would not be revealed to them until the completion of the study. Institutional review board/ethics committee approval was required for this study.

Inclusion criteria included cataract; Lens Opacity Classification System III 20, severity of nuclear opalescence 1, cortical cataract 1, posterior subcapsular cataract 1 or more causing a reduction in visual quality; regular astigmatism and no other ocular comorbidity that might influence the visual outcome. Exclusion criteria comprised active ocular disease, topographic astigmatism greater than 4.11 D (maximum correction obtainable at cornea by Acrys of IQ SN60T and SN6AT).

Patients were randomly assigned, using RAND function in Microsoft Excel, to Group A (spherical AcrysofToric SN60T IOL) or Group B (aspheric Acrysof IQ Toric SN6AT IOL). Toric IOL power and IOL orientation was calculated by IOL Master (Carl Zeiss Meditec AG) and online calculators provided by Alcon (acrysoftoriccalculator.com). In both groups, keratometry (K) notation, flat K and its axis, steep K and its axis, IOL spherical power (separately and previously calculated by SRK-T formula using IOL Master), surgical induced astigmatism (SIA), and incision location were required. An SIA value of 0.3 D was introduced according to previous personal calculations. The refractive target in all cases was emmetropia.

All surgery was performed by the same surgeon (PN) in Rajavithi Hospital using suture-less coaxial phacoemulsification through a 3.0 mm temporal clear cornea incision. The surgeon was equally experienced with both types of IOLs because they had similar platform structure. Surgeons do not know the type or group of the IOL implanted, only the power of the IOL is provided as a measure of correct IOL power. Topical anesthesia of 0.5% tetracaine hydrochloride (Alcon Laboratories, Inc) was used in all cases. Marking technique of 0 and 180 degrees was performed with the patient sitting upright and fixating on a distant target at head level with the contralateral eye under slitlamp microscopy. The slitlamp slit beam was turned in horizontal and orthograde positions and centered on the corneal apex followed by markings of the horizontal meridian at the limbususing a fine surgical marker pen. Mendez ring (Millenium Surgical Corp) was used to mark the implantation meridian intraoperatively just before surgery with the patient in the supine position on the surgical bed. The capsulorhexis diameter was approximately 5.0 mm to ensure overlap of the IOL optic for the most precise and effective lens position (ELP). After successful phacoemulsification, the IOLs were implanted by injecting with specific injector and cartridges and dialed approximately 10 degrees off the axis before removing the ophthalmic viscosurgical device (OVD). The IOL was rotated into its final position after OVD removal by exactly aligning the toric references marks with the limbal implantation axis marks.

Full preoperative ophthalmologic examination was performed in all patients including uncorrected distance (UDVA) and corrected (CDVA) distance visual acuities (LogMar charts), refractive status, slitlamp evaluation, tonometry, and fundoscopy. Aberrometry was performed using a LADAR abberrometer (Alcon

Laboratories, Inc.) which converts the data points into wavefront values using Zernike terms up to the 4th order. The value of the device in the assessment of toric IOL patients in both groups has been reported.

Patients were evaluated postoperatively at oneday, one month and three months at Rajavithi Hospital. Data analysis was performed by one of the authors (SC) once data collection was completed. The author was not involved in the care of the trial patients at the time of analysis and did not know which group was spherical or aspheric IOL. Slitlamp examination with pupil dilation was performed to evaluate any gross misalignment of the IOL that might require IOL repositioning on the first operative day and at one month. At three month follow-up, UDVA, CDVA and manifest refraction followed by aberrometry with pupil dilation using LADAR Wave wavefront sensing aberrometer (Alcon Laboratories, Inc.) were recorded in both groups.

Three months after surgery, postoperative outcomes were evaluated including analysis of UDVA and the difference between the expected and the obtained outcomes spherical equivalent (SE), the difference between expected and the obtained optical quality. The UDVA and CDVA were expressed in Log MAR notation. Also at three month follow-up, intraocular lens position and stability was observed with pupil dilation. Any subject with decentered intraocular lens or stability of the axis not at the right position was excluded from the study. Any patients not completing the follow-up examination at three months was also excluded.

The postoperative magnitude of the net residual refractive astigmatism and the difference between the expected and the obtained total astigmatism were expressed in diopters and calculated for a pupil aperture of 3.0 mm. Because preoperative and postoperative astigmatism presented different axes, they were compared using polar value analysis[19]. Residual refractive astigmatism was transformed in vector components of J0 and J45 as described by Thibos et al[20]. This method is well documented to analyze astigmatism and has been used in a previous publication[21].

The objective optical quality of all surgical eyes was evaluated by analyzing (5.0 mm pupil diameters) the root mean square (RMS) of spherical aberration Z (4,0). Intraocular aberrations were calculated by subtracting the corneal aberrations from the total aberrations to assess how much spherical aberration has changed from the preoperative state.

Statistical analysis was performed using SPSS for Windows Software (version 15.0, SPSS, Inc). The sample size was determined from data collected in previous studies. Sample size was calculated using comparision formula of sensitivity of 2 estimation methods. Using reference of study of (7) yielded that sensitivity value of estimation using EUS (P1) = 80% and sensitivity of EUS (P2) = 35%. Using this information, a 95% confidence level, a $\pm$20% precision, and a *p*-value equal to 0.05, 22 patients were determined to be needed in each group to detect significant differences between the groups. Normality of all data samples was evaluated using the Kolmogorov-smirnov test. For parametric analysis, the student t-test for paired data was performed for comparisons between preoperative and postoperative examinations or expected versus obtained data. The student t-test for unpaired data was used to compare groups. When parametric analysis was not possible, the Wilcoxon sign-rank-sum test was applied to assess the significance of the difference between preoperative and postoperative conditions or expected versus obtained data. The Mann-Whitney test was used to compare the analyzed parameters between groups. Assessing the possible correlation between measures was conducted using the Spearman's rank correlation coefficient. For all statistical tests, the same level of significance was used ($p < 0.05$).

Results

Group A consisted of 23 eyes and Group B comprised 21 eyes. Table 1 shows the preoperative conditions by group. No statistically significant between-group differences were found in age, preoperative UDVA, postoperative UDVA, CDVA, residual astigmatism and spherical equivalent. No patient was excluded from the study due to exclusion criteria or lost follow-up.

Table 2 shows the postoperative visual and refraction outcomes. No significant between-group differences were found in UDVA, CDVA or expected versus obtained refractive astigmatism. The UCVA was 0.3 log MAR or better in all eyes and 0.1 log MAR or better in18 eyes (78.26%) in group A and 18 eyes (85.71%) in group B as shown in Table 2 and Fig. 1. No statistical significance was found between groups ($p = 0.70$). The CDVA was also 100% or all eyes in both groups for 0.3 log MAR or better, 95.65% in group A and 100% in group B for CDVA of 0.1 or better as shown in Table 2 and Fig. 2. Here also, no statistical significance was found between groups ($p = 0.094$).

Table 1. Demographic characteristics of subjects corresponding 2-tail *p*-values to compare between groups are shown for each parameter.

Parameter	Spheric IOL (n = 23)	Aspheric IOL (n = 21)
Sex (n, %)		
Female	8 (34.8)	12 (57.1)
Male	15 (65.2)	9 (42.9)
Age (year)		
Mean ± SD	64.83±8.86	63.43±8.63
Range	50, 80	48, 76
pre Op UDVA (logMAR)		
Mean ± SD	1.29±0.65	1.09±0.68
Range	0.50, 2.00	0.40, 2.00
Range	-0.10, 0.20	-0.20, 0.10

Table 2. Postoperative outcome in UDVA, CDVA, residual astigmatism and spherical equivalent at 3 months after cataract surgery. Corresponding 2-tail *p*-values to compare between groups are shown for each parameter

Parameter	Spheric IOL (n = 23)	Aspheric IOL (n = 21)	*p*-value
Post Op UDVA logMAR n (%)			
0.0 or better	16 (69.6)	11 (52.4)	0.242
0.1 or better	18 (78.3)	18 (85.7)	0.701
0.2 or better	21 (91.3)	18 (85.7)	0.658
0.3 or better	23 (100.0)	21 (100.0)	N/A
Post Op CDVA logMAR			
0.0 or better	18 (78.3)	18 (85.7)	0.701
0.1 or better	22 (95.6)	21 (100.0)	1.000
0.2 or better	23 (100.0)	21 (100.0)	0.094
Residual astigmatism			
Cyl within ±0.50 diopter	18 (78.3)	16 (76.2)	1.000
Cyl within ±1.00 diopter	23 (100.0)	20 (95.2)	0.477
Emmetropia			
SQE within ±0.50 diopter	21 (91.3)	17 (80.9)	0.403
SQE within ±1.00 diopter	23 (100.0)	21 (100.0)	0.835

Values arerepresented as n (%)

The postoperative residual astigmatism within ±0.5 D was 91.30% in group A and 80.95% in group B with no significance between groups ($p = 1.00$), within ±1.0 D was 100% in all groups as shown in Table 2 and Fig. 3. Also, no significance was found between groups ($p = 0.477$). The vector analysis showed that the mean J0 was 0.09±0.20 and J45 was 0.01±0.11 in the spherical toric intraocular lens. In the aspheric toric intraocular lens, J0 was 0.14±0.23 and J45 was 0.04±0.12. No significant difference was found in residual refractive astigmatism in both groups. The mean difference of J0 and J45 in both groups was minimal (0.05) as shown in Table 3 and Fig. 4.

The residual spherical equivalent (SE) was close to ±0.5 D of emmetropia in 78.26% in group A and 76.19% in Group B as shown in Table 4 and Fig. 5. No significance was found between groups ($p = 0.403$).

Postoperative spherical aberration changes were found to be significantly lower in Group B as shown in Table 5 and Fig. 6 ($p = 0.0033$).

Discussion

Since the introduction of the IOL, the way ophthalmologists perform cataract surgery has changed forever. The evolution of IOL never stops, from an ordinary PMMA IOL to a foldable silicone IOL and foldable acrylic IOL. Visual quality has been a major issue for IOL development in the following generation,

from an ordinary spherical IOL to an image quality enhancing aspheric IOL. Nonetheless, astigmatism has been a major obstacle to overcome for achieving properimage quality. Calculating IOL tells us only the spherical equivalent that works in astigmatism less than 1 D. Astigmatism over 1 D would yield a mixed astigmatism that might produce unsatisfactory results for the patient. Toric IOL, to correct or minimize the astigmatism, has provided extremely satisfactory results for most the patients with existing corneal astigmatism ever since. The first toric IOL was introduced by Starr in 1980, but still many problems have lessened their success such as materials and

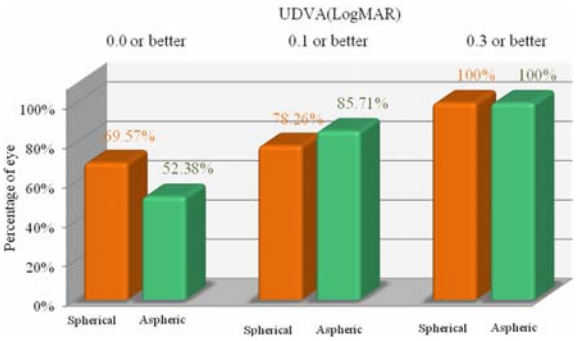

Fig. 1 Comparison of percentage of UDVA 3 months after surgery in achieving 0.0, 0.1 and 0.3 LogMarin spherical toric IOL and aspheric toric IOL group as 0.0 LogMAR is equivalent to 20/20 insnellen chart.

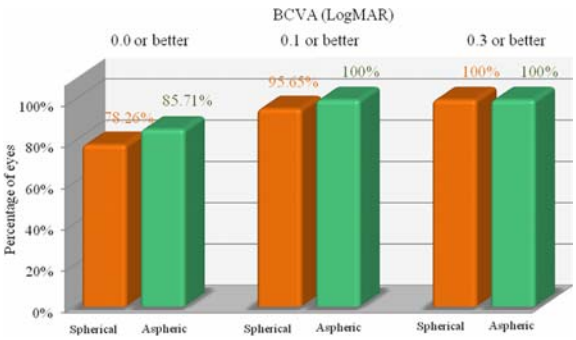

Fig. 2 Comparison of BCVA in both groups 3 months after surgery for percentage of achieving BCVA of 0.0, 0.1 and 0.3 LogMAR.

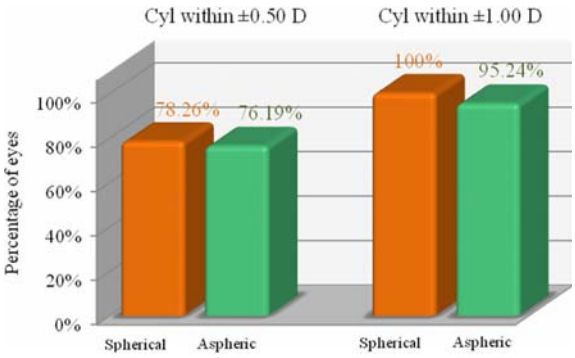

Fig. 3 Comparison of residual astigmatism at 3 months after surgery within ±0.5 D and ±1.0 D in both groups.

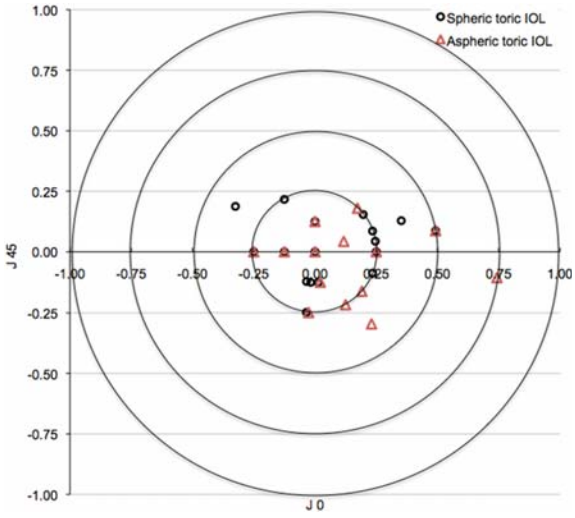

Fig. 4 Comparison in vector analysis for spherical toric intraocular lens and aspheric toric intraocular lens at 3 months after surgery.

Table 3. Mean difference residual refractive astigmatism in vector component of J0 and J45 in both groups

Parameter	Spheric IOL	Aspheric IOL	*p*-value
J0 ….			
Mean ± SD	0.09±0.20	0.14±0.23	0.470
Mean difference ± SD	0.05±0.33		
J45….			
Mean ± SD	0.01±0.11	-0.04±0.12	0.180
Mean difference ± SD	0.05±0.17		

Table 4. Spherical equivalent outcome in both groups 3 months after cataract surgery corresponding 2-tail *p*-values to compare between groups are shown for each parameter

Parameter	Spheric IOL (n = 23)	Aspheric IOL (n = 21)	*p*-value
Emmetropia (n, %)			
SQE within ±0.50 diopter	21 (91.3)	17 (80.9)	0.767
Mean ± SD	-0.01±0.19	-0.11±0.25	
Range	-0.38, 0.38	-0.50, 0.38	
SQE within ±1.00 diopter	23 (100.0)	21 (100.0)	0.835
Mean ± SD	-0.07±0.31	0.05±0.40	
Range	-0.38, 1.00	-0.50, 0.75	

Table 5. Spherical aberrations in both groups with a 5.0 mm pupil 3 months after cataract surgery corresponding 2-tail *p*-values to compare between groups are shown for each parameter

Parameter	Spherical IOL (n = 23)	Aspheric IOL (n = 21)	*p*-value
Pre Op SA			
Mean ± SD	0.73±0.36	0.95±0.37	0.289*
Range	0.49, 1.46	0.49, 1.46	
Post Op SA			
Mean ± SD	0.48±0.21	0.11±0.12	0.001*
Range	0.18, 0.73	0.03, 0.39	
Change SA			
Mean ± SD	0.28±0.27	0.84±0.36	0.003*
Range	0.01, 0.77	0.35, 1.14	

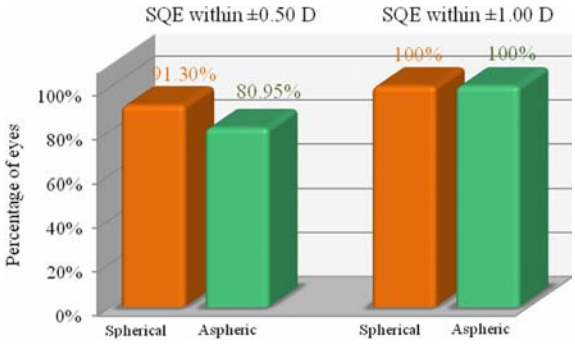

Fig. 5 Comparison of spherical equivalent outcome within ±0.5 D and ±1.0 D of emmetropia 3 months after surgery in both groups.

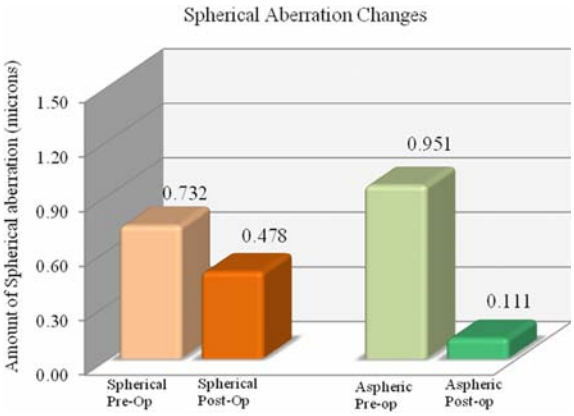

Fig. 6 Comparison of spherical aberration changes 3 months after surgery in both groups for a 5.0 mm analysis zone.

rotation[17,18]. Introduction of a single piece foldable hydrophobic acrylic IOL in the 1990s, followed by aspheric hydrophobic acrylic IOL platform improved visual quality[22]. In addition, a toric single piece foldable hydrophobic acrylic IOL by Alcon Laboratories, Inc in 2000 has made an impact in improving uncorrected distance vision without spectacles with more stability of the IOL with or without minimal rotation.

The present study has corroborated the effectiveness of both toric IOLs to correct pre-existing corneal astigmatism during cataract surgery. Three months after the procedure, the two IOLs yielded similar effective refractive results (Fig. 1). In our study, all eyes achieved 0.3 log MAR or better without any spectacles.

Postoperative residual ametropia did not significantly differ between the groups. Vector analysis of the mean difference of J0 and J45 were minimal in both groups. That means the apherictoric IOL could provide no less targeted refraction than the original spherical toric IOL. Analyzing the difference between the expected and the obtained astigmatism showed no statistical difference, meaning that both spherical and aspheric toric intraocular lens demonstrated similar results in correcting astigmatism.

Aberrrometry has successfully shown a significant difference between the two groups in postoperative intraocular spherical aberration. Spherical aberration or Z (4, 0) in Zernike polynomial has universally described the aberration of light in mathematical equation units. We have known that with the sphere lens, light rays passing through the sphere lens surface at periphery focus before the central ray thus creating spherical aberration and reducing visual function especially with dilated pupils. With the aspheric lens surface, all light rays focus at the same point and produce a better visual function. The aspheric property in non toric intraocular lens has been reported to perform better with different tasks that reflect functional vision than sphere non toric intraocular lens[23,24]. In the present study, the aspheric toric intraocular lens, with the same basic platform of sphere toric intraocular lens but with less spherical aberration, yielded better spherical aberration results which effect a better visual performance in different tasks like ones that have been reported in the non toric intraocular lens. Spherical aberration Z (4,0) with Acrys of SN6AT IOL (aspheric IOL) appeared to be statistically lower than that of Acrys of SN60T (spherical IOL) in intraocular and total aberrations with 5.0 mm pupils. Such findings could be explained by different asphericity values (-0.18 microns for Acrys of IQ SN6AT IOL opposed to positive values for Acrys of SN60T).

In conclusion, despite the difference in spherical aberration correction property, the spherical Acrys of IQ SN6AT and the aspheric SN60AT proved to be similar in clinical effectiveness in correcting astigmatism and achieving emmetropic target point. Eyes with aspheric Acrys of SN6AT IOL appeared to have significantly lower spherical aberration, meaning a better optical quality and less risks of night vision disturbances despite the same quality and efficacy in correcting astigmatism as in the Acrys of SN60T IOL. Several studies have been published assessing eyes implanted with both spherical and aspheric non-toric IOLs, showing discrepancies in relation to reported results of better visual performance with aspheric IOL than with spherical IOLs including functional vision improvement[23,24]. Having eyes with better spherical aberration would definitely mean improvement not only increasing the visual quality but also reducing the risks of night vision disturbances such as glare, starbursts and halos[25].

What is already know on this topic?

Correction of astigmatism at the time of cataract surgery can be obtained successfully by toric IOL implantation, which is extremely effective, safe and predictable.

What this study adds?

Aspheric property added in toric IOL help reduce spherical aberration; thus, enhancing the functional vision in spectacle-free lifestyle of the patient.

Potential conflicts of interest

None.

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การศึกษาเปรียบเทียบผลการใช้เลนส์แก้วตาเทียมที่แก้สายตาเอียงแบบ Aspheric กับเลนส์แก้วตาเทียมที่แก้สายตาเอียงแบบ Spherical ในการผ่าตัดผู้ป่วยต้อกระจกที่มีสายตาเอียงที่กระจกตาดำ

พิชิต นริพทะพันธุ์, พงษ์ศักดิ์ ปัจฉิมะกุล, สมพร จันทรา

ภูมิหลัง: การใส่เลนส์แก้วตาเทียมแบบไม่ได้แก้สายตาเอียงในการผ่าตัดต้อกระจกที่มีสายตาเอียงที่กระจกตาดำ มักจะได้รับผลลัพธ์ของการมองเห็นด้วยตาเปล่าที่ไม่น่าพอใจ ทำให้ต้องมีการใช้แว่นช่วยในการมองเห็นที่มีความคมชัดในที่ใกล เลนส์แก้วตาเทียมชนิดที่แก้สายตาเอียงร่วมด้วย ได้รับการพิสูจน์แล้วว่าทำให้ผู้ป่วยกลุ่มนี้มีการมองเห็นด้วยตาเปล่าที่ชัดเจนขึ้นมากโดยไม่ต้องพึ่งพาแว่นตา ปัจจุบันมีการเพิ่มคุณสมบัติที่มี asphericity ซึ่งมีรายงานการทดลองว่าเพิ่มคุณภาพการมองเห็นในเลนส์แก้วตาเทียมชนิดที่ไม่ได้แก้สายตาเอียงลงในเลนส์แก้วตาเทียมที่แก้สายตาเอียง โดยมีจุดมุ่งหมายที่จะเพิ่มคุณภาพการมองเห็นโดยไม่ต้องพึ่งพาแว่นตามากขึ้นไปอีก

วัตถุประสงค์: การศึกษานี้มุ่งหวังศึกษาผลการมองเห็นและผลการรวมแสงในเลนส์แก้วตาเทียมที่แก้สายตาเอียง 2 กลุ่ม กลุ่ม spherical (กลุ่ม A) และกลุ่ม aspheric (กลุ่ม B)

วัสดุและวิธีการ: ผู้ป่วยต้อกระจกที่มีสายตาเอียงที่กระจกตาดำได้รับการผ่าตัดต้อกระจกและใส่เลนส์แก้วตาเทียมที่แก้สายตาเอียงร่วมด้วย แบบชนิด spherical ด้วยเลนส์ Acrys of SN60T หรือแบบ aspheric Acrys of SN6AT ทำการวัดค่าระดับการมองเห็นด้วยตาเปล่าที่ไม่ต้องใช้แว่น (UDVA) แบบที่ใช้แว่นแก้ได้ดีที่สุด (CDVA) ค่าสายตาเอียงที่หลงเหลือ (residual astigmatism) ค่าเฉลี่ยของสายตา (spherical equivalent) และค่าความเพี้ยนการรวมแสงแบบ spherical aberration หลังการผ่าตัด 3 เดือน

ผลการศึกษา: จากการศึกษาทั้งหมด 44 ตา ในทั้ง 2 กลุ่ม ไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ทั้งในการมองเห็นด้วยตาเปล่า (UDVA) การมองเห็นที่แก้ได้ดีที่สุด (CDVA) ปริมาณสายตาเอียงที่หลงเหลือและค่าเฉลี่ยของสายตาทุกตาในทั้ง 2 กลุ่มมีการมองเห็นด้วยตาเปล่าในระดับ 0.3 Log MAR หรือดีกว่า มีการมองเห็นในระดับ 0.1 Log MAR ด้วยตาเปล่าเป็นจำนวน 78.26% ในกลุ่ม A และ 85.71% ในกลุ่ม B สายตาเอียงที่หลงเหลือไม่เกิน 0.5 diopter มี 91.30% ในกลุ่ม A และ 80.95% ในกลุ่ม B ความเพี้ยนในการรวมแสงแบบ spherical aberration ในกลุ่ม B ต่ำกว่ากลุ่ม A อย่างมีนัยสำคัญทางสถิติ

สรุป: เลนส์ทั้ง 2 กลุ่ม มีประสิทธิภาพเท่ากันในการรักษาเท่ากันทั้งในแง่การมองเห็นด้วยตาเปล่า การมองเห็นด้วยการแก้ไขด้วยวิธีที่ดีสุด ปริมาณสายตาเอียงที่หลงเหลือและค่าเฉลี่ยของสายตา กลุ่ม B หรือ aspheric สามารถลดความเพี้ยนการรวมแสงแบบ spherical aberration อย่างมีนัยสำคัญทางสถิติมากกว่ากลุ่ม A