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Correction of Low Corneal Astigmatism in Phacoemulsification Cataract Surgery

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Introduction

Corneal astigmatism is an issue of major concern in modern refractive cataract surgery. At least 20% to 25% cataract patients have a clinically significant amount of corneal astigmatism at preoperative evaluation. Over 90% of these have astigmatism ranging between 1.5 D to 2.5 D [1]. Residual astigmatism of more than 1.0 D after surgery can cause visual blurring and requires refractive correction with glasses [2] One popular approach to correct corneal astigmatism simultaneously during cataract surgery is by creating Limbal Relaxing Incisions (LRI) [3,4]. Another effective method is Toric IOL implantation [5].

Present study

This prospective randomized study compares the 6-month outcomes after cataract surgery with either LRIs or toric IOLs in 32 participants with corneal astigmatism between 1.5 and 2.5 D. Parameters assessed were safety and effectiveness of both methods with special attention to post op residual astigmatism.

Inclusion criteria:

- Age >40yrs.
- Visually significant cataract (LOCS grade 2-3).
- Regular corneal astigmatism between 1.5D - 2.5D.
- Axial length between 21mm to 26mm.
- Dilated pupil size >6mm to allow visualization of axis marks on toric IOL.
- Pachymetry >550µ.

Exclusion criteria:

- History of any previous ocular surgery in the same eye.
- Astigmatism outside study range.
- Corneal scarring, pterygium.
- Other associated ocular morbidities like uveitis, PEX, glaucoma, macular disorders or other retinopathies.

Methods

Preoperatively, every patient had a complete ophthalmic evaluation, including:

- Best distance corrected visual acuity
- Manifest refraction
- Slit lamp examination
- Tonometry (NCT)
- Dilated fundus examination (90D)
- Keratometry (Topcon ARK)
- Corneal topography (Oculus)
- Optical biometry (Topcon Aladdin)
- In all cases, Barrett Universal II formula for IOL power calculation was used.
- A written informed consent was taken
- 32 eyes of 32 patients were randomly divided in two groups:
- "1" for toric IOL group (15 eyes), assigned to receive toric IOL (model AcrySof IQ Toric, Alcon)
- "2" for LRI group (17 eyes), assigned to have monofocal IOL (AcrySof IQ Aspheric, Alcon) associated with LRI.
- Toric IOL cylinder power and axis placement were determined using the IOL manufacturer's online calculator (Acrysof toric IOL Calculator).
- Biometry, keratometry, incision location (110°) and the surgeon's expected surgically induced astigmatism (SIA) of 0.5 D were entered into the calculator, with emmetropia as the goal.
- A bubble marker was used to mark the corneal limbus at 3, 6 & 9 o' clock position with the patient sitting upright to avoid ocular torsion and looking straight at a distance target
- The position of marks at 0° and 180° was confirmed on slit lamp with horizontal thin slit beam and necessary adjustments made
- The reference marking was done in all cases of both the groups.
- All surgeries were performed by a single surgeon under topical/peribulbar anesthesia (Figure 1-3).

IRI procedure

It is done at the beginning of surgery. For this Donnenfield normogram is used (LRIcalculator.com). Axis marking is done with Mendez Marker. Then the Length of Incision is marked. For the incision Diamond Knife, 600µ setting is used (Figure 4 and 5).

DONO

- For 0.50 D: 1 incision 1 and a half clock hours is made.

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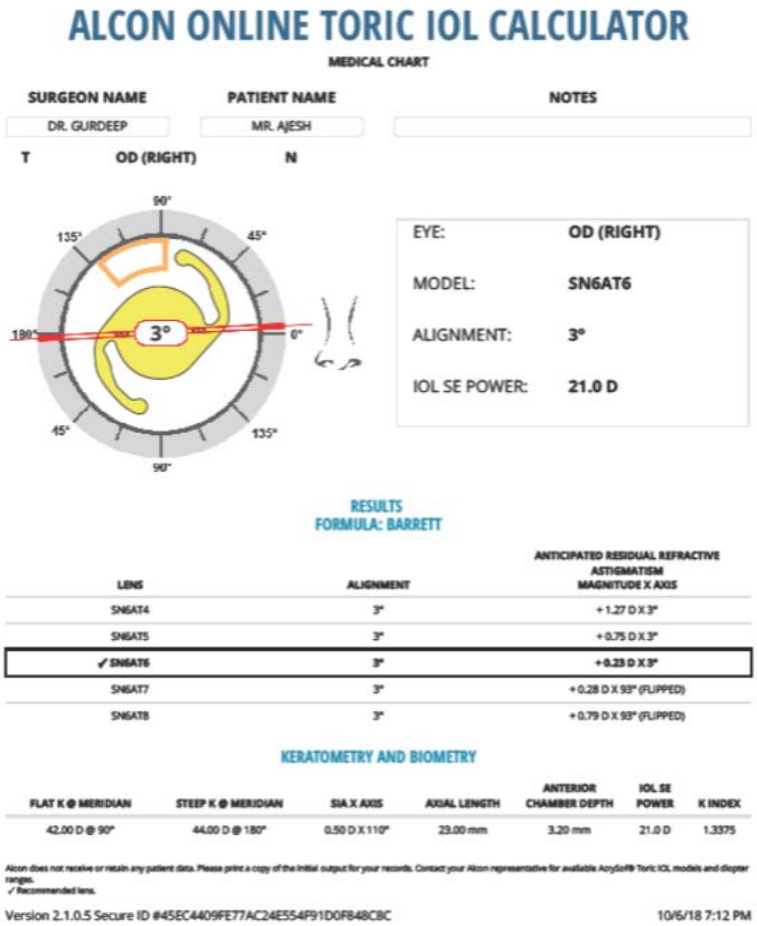

ALCON ONLINE TORIC IOL CALCULATOR

MEDICAL CHART

SURGEON NAME	PATIENT NAME	NOTES
DR. GURDEEP	MR. AJESH	

T OD (RIGHT) N

EYE:	OD (RIGHT)
MODEL:	SN6AT6
ALIGNMENT:	3°
IOL SE POWER:	21.0 D

RESULTS
FORMULA: BARRETT

LENS	ALIGNMENT	ANTICIPATED RESIDUAL REFRACTIVE ASTIGMATISM MAGNITUDE X AXIS
SN6AT4	3°	+1.27 D X 3°
SN6AT5	3°	+0.75 D X 3°
✓ SN6AT6	3°	+0.23 D X 3°
SN6AT7	3°	+0.28 D X 93° (FLIPPED)
SN6AT8	3°	+0.79 D X 93° (FLIPPED)

KERATOMETRY AND BIOMETRY

FLAT K @ MERIDIAN	STEEP K @ MERIDIAN	SIA X AXIS	AXIAL LENGTH	ANTERIOR CHAMBER DEPTH	IOL SE POWER	K INDEX
42.00 D @ 90°	44.00 D @ 180°	0.50 D X 110°	23.00 mm	3.20 mm	21.0 D	1.3375

Alcon does not receive or retain any patient data. Please print a copy of the initial output for your records. Contact your Alcon representative for available AcrySof® Toric IOL models and diopter ranges.
✓ Recommended lens.

Version 2.1.0.5 Secure ID #45EC4409FE77AC24E554F91D0F848C8C 10/6/18 7:12 PM

Figure 1:

Figure 2:

- For 0.75 D: 2 incisions, 1 clock hour is made.
- For 1.50 D: 2 incisions 2 clock hours is made.
- For 3.00 D: 2 incisions 3 clock hours is made.
- A little more for ATR and younger patient is done. A little less for older patient is done.

Surgery

For both groups, phacoemulsification was performed through a superior 2.8mm clear corneal incision. In the LRI group, a monofocal aspheric hydrophobic acrylic IOL was implanted in the bag. In the toric IOL group, the IOL was rotated to align with the planned axis. Post-op, all patients were prescribed Moxifloxacin e.d 4 times, Prednisolone e.d 6 times, Flurbiprofen e.d 4 times & HPMC e.d 2 times.

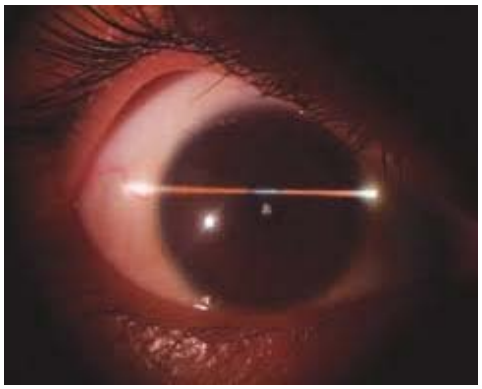

Figure 3:

Follow Up

Patients were evaluated postoperatively on day 1, day 7, at 1 month & 6 month. UCVA, BCVA, refraction & corneal topography were

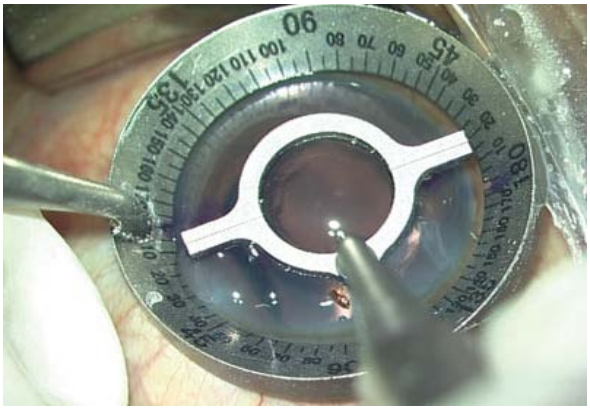

Figure 4:

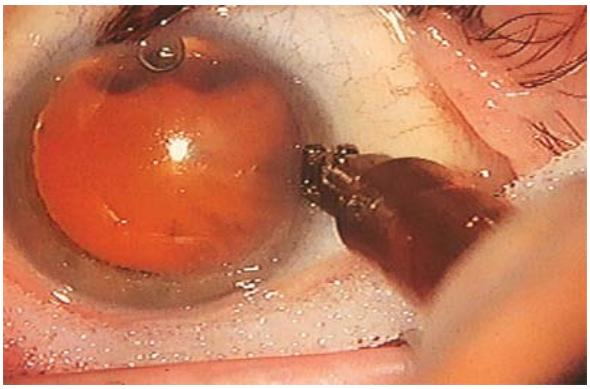

Figure 5:

performed at follow up. All patients who underwent the toric IOL implantation were further evaluated under mydriasis to determine the toric axis alignment using the coaxial slit beam.

Analysis

All data was recorded on Microsoft Office Excel 2010. SPSS statistics version 22.0 was used for all statistical analysis. The Wilcoxon signed rank test was used to compare preoperative and postoperative data and the Mann-Whitney U test was used for comparison between groups. The changes over time of the astigmatism and the value of visual acuity in each treatment group were valued using t test. P value of <.01 was considered statistically significant.

Results

A total of 32 eyes of 32 patients were included in this study. 15 eyes for the toric IOL group (1) and 17 eyes for the LRI group (2). There were no intraoperative and postoperative complications. No surgery required suturing or repositioning for a misalignment greater than 10 degrees of rotation. There were no statistical differences between the two groups before surgery in terms of demographic characteristics, biometric data, visual acuity, topographic values & refractive astigmatism (Table 1).

Both groups had a significant increase in UCVA and BCVA during the follow-up period (p <0.01).

At 1 & 6 months, UCVA was statistically higher in the toric IOL group, while BCVA did not demonstrate statistically significant differences between the two groups (Table 2 and 3).

Topographic changes were evaluated during the follow-up. At the end of 6 months, a statistically significant reduction of the mean cylinder values was observed in the LRI group. The toric IOL group did not present a significant change in topographic astigmatism over the follow-up period (Table 4).

- The change in refractive astigmatism from baseline was statistically significant (P<0.01) in both groups.
- Both groups showed a reduction of the refractive astigmatism at the end of the follow-up resulting in 0.4 D mean residual for the toric group and 1.1 D for the LRI group (P <0.01) (Table 5).

Table 1: Demographic Characteristics, Biometric Data, Visual Acuity.

Characteristics	Toric IOL Group	LRI Group
Mean Age	68.3±6.1	71.1±6.7
Sex (M:F)	9.06	9.08
Spherical IOL Power	22.4±2.9	21.7±3.4
Refractive Astigmatism	1.96±0.52	2.02±0.41
Topographic CYL	1.89±0.37	1.91±0.39
UCVA	0.75±0.27	0.79±0.31
BCVA	0.35±0.20	0.39±0.13

Table 2: PREOP & POST Operative UCVA (LogMAR).

Variable	Preop	1 Month	6 Month	*P* Value
UCVA				
TORIC	0.75±0.27	0.18±0.14	0.15±0.08	<0.01
LRI	0.79±0.31	0.33±0.09	0.27±0.12	<0.01
P	0.44	<0.01	<0.01	

Table 3: Preop & Post-Operative BCVA (LogMAR).

Variable	Preop	1 Month	6 Month	*P* Value
BCVA				
TORIC	0.35±0.20	0.05±0.03	0.04±0.03	<0.01
LRI	0.39±0.13	0.07±0.06	0.05±0.04	<0.01
P	0.59	0.87	0.83	

Table 4: Change in Topographic Cylinder.

Variable	Preop	1 Month	6 Month	*P* Value
TOPO CYL				
TORIC IOL	1.89±0.37	1.78±0.36	1.73±0.29	NS
LRI	1.91±0.39	1.14±0.41	0.91±0.37	<0.01
P	0.49	<0.01	<0.01	

Table 5: Cylinder.

Variable	Preop	1 Month	6 Month	*P* Value
REF. AST				
TORIC IOL	2.05±0.44	0.48±0.23	0.41±0.27	<0.01
LRI	1.98±0.48	1.33±0.28	1.12±0.31	<0.01
P	0.39	<0.01	<0.01	

Discussion

The main aim of modern cataract surgery is to achieve a better-unaided visual acuity with rapid post-surgical recovery, which in turn depends upon Postoperative astigmatism. This is best achieved by either using peripheral relaxing incision or using toric IOLs. Several studies have evaluated the effect of LRIs to correct low to moderate corneal astigmatism during phacoemulsification [5-8]. Carvalho et al. [3] reported a postoperative UDVA ≥20/40 in 75% of cases with LRIs, which is significantly higher than our study. . The average reduction of refractive cylinder with LRIs in our study group was around 1D.

In a recent prospective study comparing the visual outcomes of tIOL and PCRI for astigmatism of ≤3 D, both methods achieved comparable UCDVA, contrast sensitivity, and postoperative astigmatism at 3 months [9]. While in our study, UCVA was statistically higher in the toric IOL group. At 1 & 6 months while BCVA did not demonstrate statistically significant differences between the two groups.

Even though an expensive procedure, tIOLs yield more predictive results than other approaches and do not require additional corneal incisions, hence hastening visual recovery. One major complication is IOL rotation that can result in residual astigmatism. This complication, however, can be reduced by the new generations of toric IOLs.

Mingo-Botín et al. [10] compared astigmatism reduction by tIOLs versus corneal relaxing incisions and reported that refractive astigmatism was decreased in both groups. However, tIOLs more effectively and predictably reduced astigmatism. At the last follow-up examination, 15% of patients in the toric group and 45% in the relaxing incision group needed spectacles for distance vision.

The results are comparable to our study, where both groups showed a reduction of the refractive astigmatism at the end of the follow-up.

In a similar study conducted by Gangwani et al. [11], mean residual astigmatism was 0.45 ± 0.49 D in the tIOL group and 0.72 ± 0.61 D in the Peripheral Corneal Relaxing Incision (PCRI) group. They concluded that tIOLs were more predictable than PCRI for reducing astigmatism.

Where as in our study, mean residual astigmatism is 0.4 D for the toric group and 1.1 D for the LRI group ($P<0.01$)

In a study involving correction with high-power tIOL vs. lower-power tIOL combined with LRI for >2.5 D corneal astigmatism, UCDVA was better with the high-power toric group in the early postoperative period [12].

In a study done by Mendicute et al., they found that, in the toric group, 95% of eyes achieved 20/40 or better UCVA and 70%, 20/25 or better. In the OCCI group, 80% of eyes achieved 20/40 or better UCVA and 50%, 20/25 or better. All eyes achieved 20/25 or better BCVA. They concluded that toric IOL implantation achieved a slight enhanced effect over OCCIs in treating preexisting astigmatism.

In our study, in both groups, a significant increase in the BCVA was registered, while in the group treated with the toric IOL, a greater improvement of the UCVA was recorded [5].

Summary of Results

In both groups, a significant increase in the BCVA was registered, while in the group treated with the toric IOL, a greater improvement of the UCVA was recorded. In terms of change in corneal topographic values, a statistically significant decrease was recorded only in the group treated with LRI. The residual refractive cylinder after six months was about 0.4 D for the group implanted with the toric IOL and 1.1 D for the LRI group.

Conclusion

Both techniques are safe & effective in managing low to moderate astigmatism during cataract surgery. The average reduction of refractive cylinder with LRIs in our study group was around 1D. The threshold of using a toric IOL varies from surgeon to surgeon. But in majority of cases, its benefit is significant in cases having a pre-op cylinder of above 1D, because LRIs are equally effective below that range. Finally, the chief deciding factor is the cost.

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