Original Research Article

The efficacy of Toric IOL in comparison to LRI in correcting pre-existing astigmatism in phacoemulsification

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Abstract

Background: With advances in cataract procedures and IOL technology, minimizing postoperative astigmatismis becoming increasingly important. Cataract surgery has become a "true refractive surgery" because of the meticulous calculation of IOL power and correction of the pre-existing astigmatism. Hence considering the need of the hour present study was designed to find the most accurate method to correct the preexisting astigmatism. **Material and Method:** It was a Prospective interventional study in which the patients were divided into two group. In Group 1 Implantation of Toric IOL was done after cataract surgery in 20 eyes. In Group 2 Spherical IOL implantation combined with limbal relaxing incision was done in 20 eyes. **Results:** The correction of pre-existing astigmatism is more effectively achieved by the use of Toric IOL. The use of a Toric IOL reduces the complexity of the surgical procedure eliminating the need for additional incision. The results of LRI are affected by multiple factors including age, preop K, peripheral pachymetry, and inter-patient variability in corneal healing. Treating lower amounts of astigmatism, results are similar in both LRI and Toric IOL groups however in eyes with greater astigmatism, the Toric IOL was more accurate and more predictable. **Conclusion:** Both LRIs and the Toric IOL represent effective methods for correcting low to moderate amounts of corneal astigmatism.Considering the results of this study, implantation of Toric IOL is possibly the better option.
Key Words: Astigmatism,Intraocular lens,Limbal Relaxing Incision, Toric Intraocular lens.

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INTRODUCTION

With advances in microsurgical cataract procedures and foldable intraocular lens (IOL) technology, minimizing postoperative astigmatism is becoming increasingly important to meet patient expectations. The residual or induced astigmatism is one of the main factors for poor uncorrected visual acuity in the post-operative patients. This astigmatism is also responsible for the glare, monocular diplopia, asthenopia and distortion of images. Traditionally, this astigmatism has been corrected with spectacles or contact lenses. Now, patients expect to see clearly without spectacles after their cataract surgery. Approximately 15-20% of cataract patients have >1.5D of keratometric astigmatism, refractive astigmatism or both[1,2]. The cataract surgery has thus become a "true refractive surgery" because of the simultaneous correction of spherical power by meticulous calculation of IOL power and correction of the pre-existing astigmatism.

The chief methods of correcting preexisting astigmatismare as follow

1. On axis cataract incision: The 3.2mm corneal incision on the corneal axis can correct 0.25D to 0.5D of astigmatism and stability achieved in 2-3 weeks. Thus in cases with small amounts of

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astigmatism, correction can be attempted by making incision on the steepest meridian.

2. Opposite clear corneal incisions (OCCI): In phacoemulsification, the clear corneal incision has a small flattening effect on corneal curvature, which can be used to reduce pre-existing astigmatism. Adding an identical, penetrating CCI opposite the first one can enhance the flattening effect. The paired opposite CCIs are placed on the steepest meridian axis to flatten it. One CCI is used to perform cataract surgery and the opposite CCI is made to enhance the flattening effect on the cornea.
3. Limbal relaxing incision: Limbal relaxing incisions can be used with any type of cataract incision. Gills and Gayton[3], have championed the use of LRI for the management of pre-existing astigmatism in cataract patients. Louis D. Nichamin[4] emphasizedthe advantages of limbal relaxing incisions (LRI) include lack of axis rotation, ease of use with any IOL, cost efficiency and utility. They are easier to perform and more comfortable to the patient. Precise placement on axis is not as critical because the length is 4 to 12 mm. There is less variability of refraction and over corrections are rare.
4. Excimer laser ablation: PRK, LASIK, LASEK These procedures require expensive equipment and may not be indicated in an elderly population.
5. Toric iols: To correct astigmatism we need specifically designed lens, which has, cylindrical correction incorporated into it, known as TORIC IOL5

The use of TORIC IOL to reduce visually significant astigmatism offers a rational, more predictable method of refractive correction. Precise alignment of the cylinder axis of a TORIC IOL along the steep corneal meridian is critical for maximum astigmatic corrections. One degree of off – axis rotation results in loss of up to 3.3% of lens cylinder power. Sun *et al*[5] found a reduction in astigmatism of approximately 54% after Staar TF IOL implantation (preoperative corneal astigmatism about 2.81 D). The TORIC IOLs have two main limitations:

1. Rotational stability: Rotation of the IOL more than 30% from the intended axis results in increase in astigmatism instead of correction. Patel *et al* (1999)[6] concluded that the rotation of lens is caused by a haptic compression resulting from capsule contraction which was clockwise as well as counter clockwise conforming that there is no specific direction of rotation.
2. The TORIC IOLs are available only in certain powers.

MATERIAL AND METHODS

This prospective interventional study was conducted on patients of cataract with pre-existing astigmatism. Implantation of Toric IOL, Acrys of SA60T was performed after cataract surgery in 20 eyes. Spherical IOL implantation combined with limbal relaxing incision was also performed in 20 eyes. Patients Selection Criterion To Undergo Toric Iol Implantation

1. Regular astigmatism in cataractous eyes
2. Keratometry showing regular mires with steep and flat corneal meridians at or approximately 90 degrees apart.
3. Patients having astigmatism from 1.5D to 5D.
4. Informed consent for Toric IOL surgery

Exclusion Criteria

1. Irregular astigmatism
2. Previous refractive or any intraocular surgery
3. Keratoconus and other corneal pathologies
4. Lenticular astigmatism
5. Previous uveitis
6. Pre-existing fundus pathology
7. Severe dry eye
8. Advanced glaucoma
9. Retinal detachment
10. Pregnancy
11. Intraoperative complication

Our research and various studies have proven that use of Toric IOL's remain the most rational and predictable method for correcting preexisting astigmatism in cataract patients.

Although patients were selected to have toric IOL only on the basis of following criterion:

1. IOL power availability
2. Informed consent to take part in clinical trial
3. The patient having accepted that there would be an additional cost for the prosthesis

When this entire criterion was met toric IOL implantation was the procedure of choice. If any of these were not met, a spherical IOL with LRI was performed.

Preoperative Evaluation: A detailed history was taken followed by a thorough local and systemic examination.

Ocular Examination: Visual acuity followed by cycloplegic refraction was done in all the patients. Anterior and posterior segment evaluation, IOP measurement followed by IOL power calculation was done for the individuals in both groups. Unaided and best corrected visual acuity, for both distance and near was recorded.

Consent: Informed consent of the patient was taken in every case explaining the nature of the surgery and the

IOL to be implanted. The need for a regular follow-up was stressed in every case. The subjects were divided into two groups

Group 1: 20 patients. Implantation of Toric IOL after phacoemulsification.

Group 2: 20 patients. LRI after phacoemulsification with foldable IOL implantation**.**

Pre-Operative Preparation: Instillation of Moxifloxacin and Flurbiprofen eye drops four times a day was started 3 days pre-operatively. The pupil of the eye was dilated using a combination of Tropicamide 0.8% and Phenylepherine 5% eye drops.

Anaesthesia: All surgeries were performed under topical anaesthesia with Proparacaine 0.5% eye drops.

Surgical Procedure: In all the cases preoperative steep meridian was marked at the beginning of the procedure in upright position to avoid the effect of cyclorotation when the patient moves to a supine position for the cataract procedure. Next, with the patient lying on the surgical table, the steep corneal meridian was identified and marked using a Marquez gauge with the aid of the preplaced reference points. All cataracts were extracted by using topical anaesthesia and a clear corneal 2.8 mm self sealing incision was made with a keratotome. A 5 mm central, continuous curvilinear capsulorrhexis was carried out with a cystitome to ensure the overlap of the IOL border. Hydrodissection and hydrodelineation was followed by phacoemulsification of the nucleus utilizing standard chopping techniques. Irrigation and aspiration of the cortex was done. In Group 1 patients, toric IOL was implanted in the bag and was rotated in the desired axis to a point that is 15° to 20° counterclockwise of the final axis location The excess viscoelastic was removed including on the posterior side of the lens, because remnants could cause rotation of the IOL postoperatively. Final alignment of the toric IOL was performed with the help of Dumbell dialer through the sideport incision to hold the implant in place while viscoelastic was removed with the I/A tip. Then the Dumbell dialer once again used carefully to nudge the IOL into the final alignment with the axis. In Group 2 cases, LRI was performed at the conclusion of the phacoemulsification with IOL implantation. The LRI were made according to the Gills Nomogram. Clear corneal incisions were made just inside the limbus using a guarded diamond micrometer knife set at a required depth. Globe was fixed with fixation forceps and limbal relaxing incision were givenon the steepest corneal meridian. The incision site was irrigated with ringer lactatesolution.

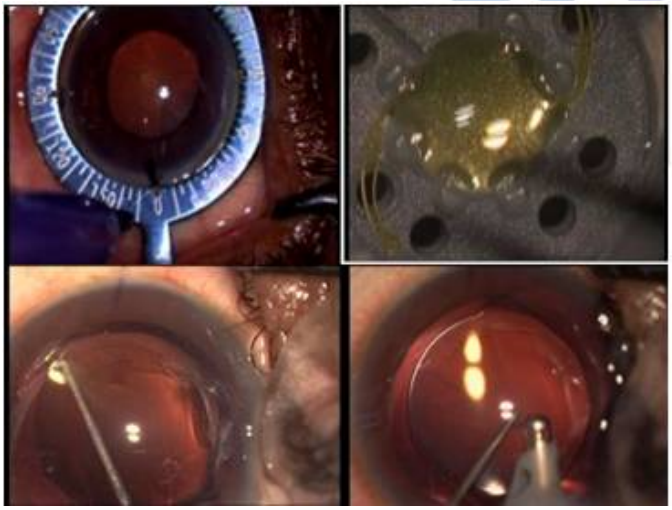

Figure 1: Acrys of Toric IOL implantation

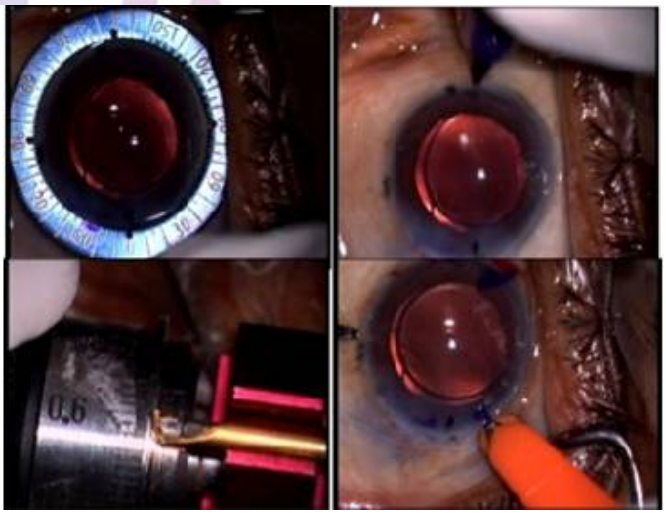

Figure 2: Limbal relaxing incison

Follow Up Post-operative evaluation was done on the post-operative 1 day, 2 weeks, 3 months.

Evaluation included:

- Unaided Visual acuity (Both for near and far)
- Slit lamp biomicroscopy
- Cycloplegic refraction
- Keratometery

The vector analysis of the surgically induced refractive change was carried out using Rectangular and Polar coordinates

The results were statistically analyzed with non parametric tests i.e. Mann-Whitney Test and Wilcoxon Signed Ranks Test and probability value was calculated.

RESULTS

Total 40 eyes were included in the study (20 Acrys of Toric IOL: Group 1 and 20 LRI's : Group 2) All patients were in the age group of 48-80 years. The mean age in Group 1 was 60.45±7.72 range 48-73 years and in Group 2 was 62.25±8.28 range 50-80 years. Total Sex distribution was: 37.5% females, 62.5% males

Group 1: 40% females, 60% males

Group 2: 35% females, 65% males

The mean IOP in Group 1 was 14.56±1.65mmHg and 14.73±1.86mmHg in Group 2. The mean axial length was 23±0.08 in Group 1 and 23.48±0.9 in Group 2. The pre-existing corneal astigmatismin

Group1: Mean 2.55 ± 1.09 D (range 1.50-5.09)

Group 2: Mean 2.11 ± 0.62 D (range 1.30-3.13)

The pre- operative Unaided Visual Acuity (LogMar)

Group 1: 0.650 ± 0.28

Group 2: 0.810 ± 0.21

Preoperative mean Astigmatic axis in

Group 1: 99.60 ± 49.13 degree (4.0 -180)

Group 2: 99.80 ± 48.89 degree (10.0 -180)

Astigmatism: Residual astigmatism in Group 1 The preoperative mean astigmatism was 2.55 ± 1.09 D At 1st postoperative day the mean astigmatism was 1.05 ± 0.67D (0.50-2.75) Percent change from preoperative to first postoperative day: 60.02 ±13.54% (33.33-80.00) At 2nd week the mean astigmatism was 0.78 ± 0.71 D (0.0 - 2.50) Percent change from preoperative day to 2nd week: 72.43 ± 14.93% (40.05 -100) At 3rd month the mean astigmatism was 0.60 ± 0.54 (0.0-2.00) Percent change from preoperative to 3rd month: 79.31. ± 12.68% (36.10 - 83.33) p < 0.001 Highly significant Residual astigmatism in Group 2 The preoperative mean astigmatism was 2.11 ± 0.62 D At 1st postoperative day the mean astigmatism was 1.71 ± 0.69D (0.50-2.75) Percent change from preoperative to first postoperative day: 20.45 ±16.69 % (5.30-72.22.00) At 2nd week the mean astigmatism was 1.23 ± 0.58 D (0.50 -2.00) Percent change from first postoperative day to 2nd week: 43.55 ± 14.96% (20.0 - 72.22) At 3rd month the mean astigmatism was 0.82 ± 0.40(0.25-2.00) Percent change from 2nd week to 3rd month: 61.48 ± 12.18% (36.10 - 83.33) p < 0.001 Highly significant Axis Deviation In Degrees Preoperative mean Astigmatic axis in Group 1: 99.60 ± 49.13 degree (4.0 - 180) On 1st Postoperative day mean astigmatic axis: 109.95 ± 39.82 On 2 week mean astigmatic axis: 103.90 ± 48.10 On 3rd month mean astigmatic axis: 90.25 ± 59.59 P > 0.05, not significant Group 2: 99.80 ± 48.89 degree (10.0 -180) On 1st Postoperative day mean astigmatic axis: 107.60 ± 43.57 On 2 week mean astigmatic axis: 109.90 ± 43.87 On 3rd month mean astigmatic axis: 108.75 ± 43.79 P > 0.05, not significant.

Table 1: Change in astigmatism in both the groups over period of 3 months

		PRE-OP	POST OP		
			DAY 1	2 WEEK	3 MONTH
Group 1	Astigmatism(D)	2.557±1.09	1.05±0.67	0.78±0.71	0.60±.54
	%Change		60.02%	72.43%	79.31%
Group 2	Astigmatism(D)	2.11±0.62	1.71±0.69	1.23±0.58	0.82±0.40
	%Change		20.45%	43.55%	61.48%

Table 2: Change in the astigmatic axis in both the groups over period of three months.

	PRE-OP ASTIGMATIC AXIS (degrees)	POST-OP ASTIGMATIC AXIS (degrees)		
		DAY 1	2 WEEK	3 MONTH
Group 1	99.60±49.13	109.95±39.82	103.90±48.10	90.25±59.59
Group 2	99.80±48.89	107.60±43.57	109.90±43.87	108.75±43.79

Visual Acuity: The preoperative Unaided Visual Acuity (LogMar)

Group 1: 0.650 ± 0.28

Group 2: 0.810 ± 0.21

Uncorrected Visual Acuity (UCVA) at 3rd month

Group 1: 0.155 ± 0.11

Group 2: 0.225 ± 0.09

p value: 0.021, significant.

Best Corrected Visual Acuity (BCVA) at 3rd month

Group 1: 0.040 ± 0.075

Group 2: 0.070 ± 0.080

p value:0.158, not significant

Table 3: Comparison of BCVA in both the groups at the end of 3 months

			POST OP VISION BCVA				Total
			6/6	6/6p	6/9	6/9p	
GROUP	GROUP 1 – TORIC IOL	Count	15	2	2	1	20
		% within GROUP	75.00%	10.00%	10.00%	5.00%	100.00%
	GROUP 2- LRI	Count	10	6	4	0	20
		% within GROUP	50.00%	30.00%	20.00%	0.00%	100.00%
	Total	**Count**	25	8	6	1	40
		% within GROUP	62.50%	20.00%	15.00%	2.50%	100.00%

DISCUSSION

With the opportunity for highly accurate biometry and the availability of multifocal IOL's, aspheric IOL's, and combined cataract and astigmatic surgery, cataract surgery has become a refractive surgical procedure. Budak *et al*[7] reported that patients with more than 1.50 to 2.00 D of astigmatism are generally considered candidates for some form of surgical astigmatic correction. In this prospective study we have attempted to evaluate the efficacy of Toric Intraocular Lenses and LRI in correcting the preoperative astigmatism in phacoemulsification. There was no statistically significant difference between the two groups chosen for study seen as far as the age, gender and pre op astigmatism is considered. We followed our patients till 8 weeks and the follow up interval was fixed on 1st postoperative day, 2nd postoperative week and 8th postoperative week. The interval selection was based on the fact that the surgically induced change stabilizes at the end of 8th postoperative week in most of the cases. In a recent study of Acrysof Toric IOL, Dr Abhay R. Vasavada *et al*[8] studied results at 1st postoperative day and at 3 months postoperatively. The preoperative keratometeric astigmatism was 2.55±1.09 D in Group 1 (Toric IOL) and 2.11±0.62 D in Group 2 (LRI). At third postoperative month, In Group 1 the residual astigmatism was 0.60±0.54D.The mean reduction was of 1.95 D (79.31%) Percent change from preoperative to 3rd month: 79.31. ± 12.68% (36.10 - 83.33) $p < 0.001$ Highly significant while in Group 2, the residual astigmatism at the end of 3rd month was 0.82±0.58D and the mean reduction was of 1.29D (61.48%). Percent change from 2nd week to 3rd month: 61.48 ± 12.18% (36.10 - 83.33) $p < 0.001$ Highly significant. In an another study by Edward J.Holland[9] at 3 months the mean residual cylinder was 0.42±0.46D in the Acrysof Toric IOL Group In a 1 year follow up study by B Golenvaux and S Benchekroun[10]at 3 months, the mean residual cylinder was 0.56±0.6D in the Acrysof Toric IOL Group. On first postoperative day there was significant difference in residual astigmatism in both the groups but there was greater amount of astigmatism correction in immediate postoperative day by implantation of Toric IOL as compared to LRI. In a study by Carvalho MJ *et al*[11] a statistically significant reduction in the mean topographic astigmatism was seen in the cataract LRI eyes from 1.93 +/- 0.58 diopters (D) preoperatively to 1.02 +/- 0.60 D 6 months postoperatively. In LRI study of 37 patients by Bayramlar Hüseyin, Daglioglu Mutlu C, Borazan Mehmet[12] mean preoperative and postoperative refractive astigmatism was 3.31 D ± 1.50 and 1.59 ± 1.28 D, respectively at the end of 6 months. The mean absolute change in refractive astigmatism was 1.72 ± 0.81D. In an another study to evaluate LRI in 32 patients by Coloma González, González Herrera, Mengual Verdú, Hueso Abancens[13] three months after surgery, the mean astigmatism change was -0.55D (-0.75 to -0.35). The astigmatism correction continues to be higher in Toric IOL group as compared to LRI Group on 2nd postoperative week.Table 1 and Table 2 The statistical analysis of our study at the 3rd month reveals that the correction of pre-existing astigmatism can be more effectively achieved by the use of Toric IOL. Our study as well as all other studies show that both LRIs and the Toric IOL represent effective methods for correcting low to moderate amounts of corneal astigmatism and may be considered essential tools for maximizing patient satisfaction and achieving successful visual outcomes after cataract surgery. However the introduction of Toric IOL allows greater, predictable and stable correction of pre-existing astigmatism at the time of cataract surgery.

Post-Operative Visual Status: At 3 months, mean monocular distance uncorrected visual acuity (UCVA) in Group 1 was 0.155±0.11 (Logmar) and Group 2 was 0.225±0.09. In Group 1, 6/6p uncorrected visual acuity was achieved by 7 out of total 20 patients (35%) and 6/6 UCVA was achieved by 3 patients (15%). While in Group 2, 6/6p uncorrected visual acuity was achieved by 2 patients (10%) and 6/6 UCVA was achieved by none. Best corrected visual acuity (BCVA) in Group 1 was 0.040±0.075 (Logmar) and Group 2 was 0.070±0.080. In Group 1, 6/6 BCVA was achieved by 15 patients (75%) while in Group 2 by 10 patients (50%). (Table 3) Mean UCVA and BCVA are better in Toric IOL group indicating that Toric IOL provides more precise correction. In a study of Star Toric IOL for correcting astigmatism in 130 eyes by Xiao-Yi Sun *et al*[5], 84% of eyes achieved 20/40 or better UCVA.

In a similar study performed on 30 eyes, Mendicute *et al*[14] also reported a UCVA of >20/25 in 66% eyes and >20/40 in 93% at 3 months following implantation of the AcrySof toric IOL. The uncorrected visual acuity was better in Toric IOL group than LRI group, more patients attaining 6/6 visual acuity. The best corrected visual acuity was also better in Toric IOL as compared to LRI group however not that significantly but still demonstrating more opportunity for vision to be improved with glasses after this procedure. The use of a Toric IOL reduces the complexity of the surgical procedure correcting astigmatism in cataract extraction, eliminating the need for additional corneal incisions and minimizing the risks and complications associated with them. The less impressive results of LRI Group reflects the poor predictability of the technique where multiple factors including patient age, preoperative K, peripheral pachymetry, and inter-patient variability in corneal

healing, can all influence the outcome. Furthermore, the outcome predictability of LRIs decreased with increasing amount of targeted astigmatism correction. Whereas residual astigmatism outcomes were similar in the LRI and Toric IOL groups when treating lower amounts of astigmatism, in eyes with greater astigmatism, the Toric IOL was more accurate and more predictable.

CONCLUSION

Both LRIs and the Toric IOL represent effective methods for correcting low to moderate amounts of corneal astigmatism and may be considered essential tools for maximizing patient satisfaction and achieving successful visual outcomes after cataract surgery. Considering the results of our study, implantation of Toric IOL is possibly the better option in cases with moderate astigmatism however long term and larger study groups are required to further confirm our results.

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