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Comparative Study on Toric Intraocular Lens vs Peripheral Corneal Relaxing Incisions to Correct Astigmatism in Eyes Undergoing Cataract Surgery

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Abstract

Purpose: To compare Toric IOLs and Peripheral corneal relaxing incisions for correcting pre-operative astigmatism in eyes undergoing cataract surgery. *Setting:* M. D. Eye Hospital, Regional Institute of Ophthalmology, Prayagraj, India. *Design:* Prospective Observation study. *Method:* Eyes with astigmatism of ≥1.5 D undergoing cataract surgery either with the rule astigmatism (WTR) or against the rule astigmatism (ATR) confirmed by corneal topography between November 2018 to October 2019 were included in the study. The same surgeon performed phacoemulsification/SICS with PCRI to reduce pre-existing astigmatism. *Result:* In our study 35 eyes of 35 patients were included. 10 eyes of 10 patients underwent Toric IOL implant who had >2.00 D of astigmatism & 25 eyes of 25 patients had mild astigmatism and underwent SICS with PCRI. Patients were followed up regularly till 10 weeks. In Toric IOL implant group 90% patients of moderate to higher order astigmatism had BCVA in the range of 6/9–6/6. Eyes underwent SICS with PCRI 60% of the patients had BCVA 6/9-6/6. Only few patients required cylindrical glasses post-operatively. *Conclusion:* PCRI cannot be used for moderate to high astigmatism. Spectacle dependence of PCRI group was more than Toric IOL group. Although cost wise PCRI is better option over Toric IOL implant for correcting pre-operative astigmatism.

Keywords: With the Rule (WTR) astigmatism; Against the rule (ATR) astigmatism; Peripheral corneal relaxing incision (PCRI).

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Introduction

Astigmatism accounts for approximately 13% of all refractive errors.[1,2] Over 20% of the patients attending for cataract surgery have >1.5D of astigmatism, 8% have >2.0D and 2.6% have >3.0D astigmatism.[3-6] Uncorrected astigmatism of >0.75D can cause visual blurring, ghosting of images or halos.[7,8]

Every procedure performed on the cornea induces a certain amount of astigmatism, even phacoemulsification for cataract surgery. Corneal incisions made during cataract surgeries reduce corneal power on the meridian of incision.

With the advancement in the cataract surgery from ICCE to ECCE to Phacoemulsification; visual outcome to the patients increases dramatically. Now this is the era of cataract surgery with specially designed IOLs like Toric IOLs and procedures like peripheral corneal relaxing incisions (PCRIs) or limbal relaxing incisions (LRIs) to significantly reduce the post operative astigmatism in desired way.

In this modern era of cataract surgery where the expectations of the patient are very high for the outcome of the surgery i.e. in the form of increased visual acuity, good color contrast sensitivity, reduction of glare and spectacle independence etc.[12] The refractive astigmatism is sum of both corneal

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astigmatism as well as lenticular astigmatism, but after cataract surgery lenticular component abolishes, so if we handle corneal astigmatism during the cataract surgery better outcomes of the cataract surgery in the form of reduced glare and spectacle independence can be achieved post operatively.

So, astigmatism during the cataract surgery can be corrected by following methods:[13]

1. Selective positioning of phaco incision
2. Peripheral relaxing incisions (Limbal relaxing incision and corneal relaxing incision.)
3. Toric IOL implant.

All these methods are good in context of reducing preoperative astigmatism; but selective positioning of incisions[14] and peripheral relaxing incisions are useful for correcting only mild corneal astigmatism whereas toric IOLs are specially designed lenses which can correct very high order astigmatism (upto 12D).[15]

The current study is a prospective study to compare the toric IOL vs PCRI to correct astigmatism in eyes undergoing cataract surgery.

Aims and Objectives

1. To compare the Toric Intra Ocular Lenses vs Peripheral corneal relaxing incisions to correct astigmatism in eyes undergoing cataract surgery.
2. To determine the degree of astigmatism pre-operatively in patients undergoing cataract surgery.
3. To record the final refractive outcome of the patient after the surgery.

Methods

This prospective observational study was conducted at Regional institute of Ophthalmology (M. D. Eye Hospital) PrayagRaj between December 2018 to November 2019. This study was approved by ethical committee of M.L.N. Medical College, PrayagRaj. The participants of this study were recruited from the OPD of Deptt. Of Ophthalmology, RIO PrayagRaj.

They were given a patient information and consent sheet and given an opportunity to read and discuss participation with their family members.

Participants were free to talk to the co-ordinator of the study as well as they can withdraw at any point of time.

Inclusion Criteria

1. Patients of both genders.
2. Patients of age 40– 70 yrs.
3. Pre operative regular astigmatism > 1.5D
4. Pre-operative mydriasis of more than 6.0 mm.
5. Otherwise healthy retina with normal fundus.
6. If diabetic, then <5 years of disease and HbA1c <6.0 (good glycemic control).
7. Patients with grade I-IV cataract were considered in this study and grade IV cataract were taken for SICS with PCRI because it is difficult to perform phacoemulsification in grade IV cataract.
8. Mostly low to moderate astigmatism patients were considered for SICS with PCRI whereas higher order astigmatism were implanted with toric IOL if cataract grade was ≤ grade III.

Exclusion Criteria

1. Patients having preoperative astigmatism of <1.5 D or irregular astigmatism.
2. Patients having corneal pathology or history of penetrating trauma or history of penetrating keratoplasty.
3. Patients having optic atrophy.
4. Retinal detachment and other retinal pathology.
5. Any history of previous ocular surgery.
6. Immunocompromised patients having HIV, HBV or HCV.
7. Uncontrolled diabetes ; > 5 years of disease or > 6.0 HbA1c (poor glycemic control).

Preoperative Evaluation

Pre operatively all patients underwent general and ophthalmic evaluation and pre-operative work up for cataract surgery which includes:

- Complete relevant history was taken including name, age, sex, residence and occupation.
- Preoperative uncorrected (UCVA) and best corrected visual acuity (BCVA) were recorded.
- Refraction and Assessment of spectacle correction if required.
- Slit lamp examination was done to look out any corneal, anterior chamber or iris pathology.

- NCT/ Applanation tonometry for recording IOP
- Intraocular pressure was recorded to rule out glaucoma
- Fundus examination of both eyes was done by direct and indirect ophthalmoscope to rule out fundus pathology.
- Keratometry reading were be recorded by the help of Bausch & Lomb manual keratometer.
- Corneal topography was done with the help of Tomey topographer.
- IOL power calculation was done with A-scan biometry.

Sampling Technique

A total 35 patients met the inclusion criteria. The sampling technique was non-probability convenience sampling and the patients divided into two groups – Group A and Group B.

Group A: included 25 eyes of 25 patients, which underwent SICS (Temporal or Supero temporal incision) with 1 peripheral corneal relaxing incision (PCRI).

Group B: included 10 eyes of 10 patients, which underwent toric IOL implantation.

All the surgeries either PCRI or Toric IOL implantation in all eyes were performed by experienced senior surgeon Prof. K.J. Singh of the institute.

Surgical Procedure

Anterior keratometric data was obtained by Bausch & Lomb manual keratometer and if significant regular astigmatism was found then amount of astigmatism and meridian was confirmed by topography (Tomey Topographer). A minimum of 3 images were taken and best was saved for data analysis. All participants were underwent their biometry on IOL Master (Carl Zeiss Meditec, Germany).

A single experienced right handed surgeon (Prof. K. J. Singh) performed all cataract surgeries under peri-bulbar anesthesia. On the day of operation eye was again fully dilated and examined thoroughly and marking on slit-lamp in upright position was done at 0 and 180. The participant was asked to fixate on a distance target and requested not to blink during the marking procedure.

a) *PCRI procedure:* A single PCRI was placed on the limbus prior to the commencement of the cataract surgery using 0 and 180 ink marks as reference. After draping the patient a standard 600 micron PCRI was made close to the limbus with the help of diamond knife.

   A 5.5 mm temporal or superotemporal corneal tunnel was created and anterior chamber was filled with viscoelastic substance. A CCC of 5mm size was made and nucleus was removed after hydrodissection. After thoroughly washing the cortical matter again viscoelastic was pushed in to the anterior chamber to inflate the capsular bag and a rigid PCIOL was placed. After implantation of PCIOL care was taken to remove all the viscoelastic material from sides as well as behind the PCIOL to prevent instability of the lens.

b) *Toric IOL procedure:* toric IOL power was calculated by using toric calculator provided by Care group also taking into account the SIA of 0.5D. Mendez ring (Endo webal) was used to mark the toric axis. Phacoemulsification was carried out via 2.8 mm clear corneal incision and customized toric with plate haptic (Care group) was implanted with due consideration of toric IOL axis marked with Mendez ring (Endo webal). A careful irrigation and aspiration was performed to remove the residual viscoelastic from anterior chamber and behind the tIOL. The final recheck of the tIOL axis was made by seeing the movement of micro bubbles created by hydro canula of 26G. Finally the AC was filled with BSS and procedure completed with intra cameral antibiotic and stromal hydration of wounds to seal it.

Follow-up

Patients were followed postoperatively at 1st post-op day, 2nd week and 10th week then monthly till the end of study.

The following outcomes were noted:

- Uncorrected and/or best corrected visual acuity.
- Intraocular pressure; if required (by Goldamnn Applanation Tonometer).
- Slit lamp examination.
- Kerotometry by Bausch & Lomb manual keratometer.
- Corneal topography by Tomey topographer.
- Fundus examination by direct or indirect ophthalmoscopy.

- Complications like hyphema, corneal edema, secondary glaucoma, anterior chamber reactions, TASS, iris atrophy, endophthalmitis & cystoid macular edema were noted.

Observation and Result

Patient characteristics are summarized as shown in table 1.

Table 1: Patient demographic and clinical information.

Parameter		Value
Mean age (y) ± SD		61.71±7.30
Mean age (y) ± SD		
	SICS with PCRI	63.04±5.92
	Toric IOL	58.40±9.15
No. of Patients		
	SICS with PCRI group	25
	Toric IOL implant group	10
Sex %		
	Male	20 (57.14%)
	Female	15 (42.86%)
Side(%)		
	Right eye	20 (57.14%)
	Left eye	15 (42.86%)

Preoperative difference in keratometry was in the range of 2.00–2.99 in 16 cases (45.7%) followed by 10 cases (28.6%) had ≥3.00 and least in the range of 1.00–1.99 i.e. in 9 cases (25.7%).

Table 2: Preoperative difference in Keratometry (ΔK).

ΔK	PCRI (%)	Toric (%)	Total (%)
1.00–1.99	9 (36)	0	9 (25.7)
2.00–2.99	13 (52)	3 (30)	16 (45.7)
≥3.00	3 (12)	7 (70)	10(28.6)

So, it is evident from above bar chart that most of the patients of PCRI group had keratometry difference in the range of 2.00–2.99D i.e. 13 cases (52%) followed by 9 (36%) patients had ΔK in the range of 1.00–1.99D and least number of cases i.e. 3 cases with keratometry difference of ≥3.00D. In Toric IOL group majority of the cases had keratometry difference of ≥3.00D i.e. 7 cases (70%) followed by 3 patients (30%) in the range of 2.00–2.99D and none of the patients had <2.00D keratometry difference.

In our study mainly two types of astigmatism i.e. WTR (with the rule) & ATR (against the rule) were considered and majority of the cases taken were of ATR types. Out of total 35 eyes 28 eyes (80%) had ATR astigmatism whereas only 7 eyes (20%) had WTR astigmatism which was comparable in both thje groups.

In our study majority of the patients i.e. 25 patients (71.4%) had preoperative BCVA (Best corrected visual acuity) in the range of HM–6/36.

Table 3: Best corrected visual acuity (BCVA) before surgical procedures.

Best Corrected Visual Acuity (BCVA)	PCRI Patients (N=25)	Toric IOL Patients (N=10)	Total Patients (N=35)
HM	5 (20%)	1 (10%)	6 (17%)
1/60 – 5/60	4 (16%)	2 (20%)	6 (17%)
6/60	3 (12%)	1 (10%)	4 (12%)
6/36	6 (24%)	3 (30%)	9 (26%)
6/24	2 (8%)	3 (30%)	5 (14%)
6/18	3 (12%)	0	3 (8%)
6/12	2 (8%)	0	2 (6%)

Preoperative best corrected visual acuity was examined. Majority of the patients in Group A (PCRI) had best corrected visual acuity in the range of HM- 6/36 which is about 70% of total PCRI Group patients. In Toric IOL Group majority of patients had best corrected visual acuity in range of 6/36 – 6/24 (60%).

Table 4: Comparison of best corrected visual acuity at 10th week after surgical procedure.

Best Corrected Visual Acuity (BCVA)	PCRI Patients N=25 N (%)	Toric IOL Patients N =10 N (%)
< 1/60	0%	0%
1/60–5/60	0%	0%
6/60–6/24	2 (8%)	0%
6/18–6/12	8 (32%)	1 (10%)
6/9–6/6	15 (60%)	9 (90%)

The best corrected visual acuity at 10th week in the range of 6/9–6/6 of both group A (PCRI) and group B (Toric IOL) were 60% and 90% respectively. Toric IOL group there was more improvement in BCVA at 10th week.

Discussion

As a result of theoretical and technological developments in cataract surgery, surgeons can now replace the cataractous lens with an artificial lens in a minimally invasive procedure, increasing the significance of the refractive outcomes. To optimize visual outcomes and minimize spectacle dependence, both the spherical and the astigmatism components of the refractive error must be addressed. The prevalence of astigmatism increases with age. It is estimated that approximately 50% of the population older than 60 years has more

than 1.00 diopter (D) of astigmatism and that up to 22% of cataract surgery candidates have pre-existing astigmatism exceeding 1.50 D. Although not firmly established, the level of cylindrical defect that can be considered clinically significant is approximately 0.50 to 1.00 D. Treatment options to address preoperative regular astigmatism include positioning or enlarging the main incision, performing astigmatic keratotomy, creating opposite clear corneal incisions, using laser ablative procedures, and implanting a toric intraocular lens (IOL). In eyes with low to moderate astigmatism, creating peripheral corneal relaxing incisions (PCRIs), also known as limbal relaxing incisions (LRIs), is one of the most widespread techniques. Although less powerful than keratotomies that are more central, the advantages of these incisions include a lower risk for induced irregular astigmatism, a consistent 1:1 coupling ratio, ease of execution, and fewer complications. Moreover, studies of recently introduced toric IOLs show them to be a promising option with excellent outcomes. This study compared the effectiveness, predictability, and safety of both techniques in the treatment of preoperative astigmatism during cataract surgery. Outcomes included visual and refractive results and quality of life and need for spectacles. In our study we categorized the patients in to 3 groups on the basis of difference in keratometry (ΔK) i.e. 9 patients (25.7%) having keratometry difference in the range of 1.00–1.99D, 16 patients (45.7%) having keratometry difference of 2.00–2.99D and 10 patients (28.6%) having keratometry difference ≥3.00D. The mean of ΔK in whole study group was 2.42±0.81D and the mean of ΔK in both groups PCRI and toric group was respectively 2.08±0.56D and 3.28±0.75D. Similarly study done by Bachernegg A. et al[9] the pre-operative ΔK was 3.29±0.84D which is almost similar to our study. All other studies done by different authors like Mingo Botin et al[10] and Javier Mendicute et al[11] taken pre-operative astigmatism (ΔK) <3.00D so they encountered mean ΔK less than our study. In study done by Mingo Botin et al[10] mean ΔK 1.91± 0.48D in PCRI group and 1.73±0.38D which is significantly less than our observation. In study done by Javier Mendicute et al[11] mean ΔK in PCRI group was 1.77±0.12 and mean ΔK in Toric IOL group was 1.90±48. In our study pre-operative BCVA(Best Corrected Visual Acuity) was done by Snellen's chart and 6 patients (17%) had HM vision, 6 patients (17%) in the range of 1/60–5/60, 4 patients (12%) had 6/60 as BCVA, 9 patients (26%) had BCVA of 6/36, 5 patients (14%) had BCVA 6/24, 3 patients (8%) had 6/18 and 2 patients (6%) had 6/12 as BCVA. None of the patients had pre-op BCVA better than 6/12. For better comparison of visual acuity with different authors we converted Snellen's Visual Acuity into LogMAR scale. So, in our study, mean LogMAR best corrected visual acuity pre-operatively was 1.0378±0.47. In both the groups pre-op LogMAR best corrected visual acuity was 1.0053±0.51 and 1.1192±0.38 in PCRI group and Toric IOL implant group respectively. In PCRI group there were total 25 patients in our study in which 5 patients had WTR astigmatism and 20 patients had ATR astigmatism. In ATR astigmatism we performed SICS with temporal incision along with 1 PCRI whereas in 5 patients who had WTR astigmatism were underwent SICS with superotemporal incision along with 1 PCRI because all the patients of the WTR astigmatism was operated for right eye (RE) so superotemporal incision was given. In Toric IOL implant group all 10 patients underwent phacoemulsification surgery via temporal route and plate haptic Toric IOL (Ultima smart toric by Care group) was placed according to the axis provided by toric calculator. There was significant improvement in the best corrected visual acuity at 10th week postoperatively. The best corrected visual acuity at 10th week was mostly in the range of 6/9–6/6 in both the groups. BCVA in Group A (PCRI) and group B (Toric IOL) was 60% and 90% respectively. In Toric IOL group there was more improvement in BCVA at 10th week. In LogMAR the BCVA of all 35 patients 10th week post-operatively was 0.502±0.36. LogMAR value of BCVA for both the groups i.e. PCRI group and Toric IOL group was 0.429±0.33 and 0.183±0.14 respectively. In Toric IOL implant group there were total 10 patients in this study and 9 out of 10 had BCVA in the range of 6/9–6/6 and none of them received cylindrical glasses more than 0.50 D, only one patient received cylindrical glass of 1.50 D in whom intra-operative complication in the form of PCR was occurred and Iris claw lens was implanted. In PCRI group majority of patients achieved good vision without cylindrical glass prescription but if cylindrical glass was required was not more than 1.00D in any case. Out of the 35 cataract operated patients with regular corneal astigmatism, all had a history of spectacle usage preoperatively. 23 (65.71%) patients did not require spectacles post operatively whereas 12 (34.29%) still required to be prescribed glasses after final follow up at 10th week.

Conclusion

In our study we found that Toric IOL implant was superior than peripheral corneal relaxing incision because later method had limited application in following situations

1. Peripheral corneal relaxing incision cannot be used for moderate to high astigmatism.
2. Results obtained by peripheral corneal relaxing incision are not predictable and more or less depends on surgical skills of the surgeon.
3. Spectacle dependence of PCRI group was more than Toric IOL implant group in our study as well as study by different authors.
4. Although cost wise PCRI is better option over Toric IOL implant for correcting pre-operative astigmatism.
5. But toric IOLs had better predictability and precision over PCRI for correcting pre-operative astigmatism.
6. In cases with pre existing corneal astigmatism toric IOLs are the best possible intervention and continues to remain the gold standard.

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