




Original Article

Visual and Refractive Outcomes Following Phacoemulsification with Toric Versus Non-Toric Intraocular Lens Implantation In Patients with Pre- Existing Corneal Astigmatism

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ABSTRACT

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Background; Pre-existing corneal astigmatism is common among cataract patients and may adversely affect postoperative visual outcomes if left uncorrected. Toric intraocular lenses (IOLs) have been developed to correct astigmatism during cataract surgery and improve postoperative visual quality.

Aim; To compare the visual and refractive outcomes following phacoemulsification with toric versus non-toric intraocular lens implantation in patients with pre-existing corneal astigmatism.

Materials and Methods; This prospective comparative observational study was conducted in the Department of Ophthalmology at PES Institute of Medical Sciences and Research over a period of one year. A total of 100 patients with senile cataract and pre-existing corneal astigmatism were included and divided into two groups of 50 patients each. Group T underwent phacoemulsification with toric IOL implantation, while Group NT received non-toric IOL implantation. Preoperative and postoperative evaluations included uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), residual refractive astigmatism, spectacle dependence, and postoperative complications. Statistical analysis was performed using SPSS version 25.0, with $p < 0.05$ considered statistically significant.

Results; The mean postoperative UCVA at 3 months was significantly better in Group T (0.12 ± 0.08 LogMAR) compared to Group NT (0.34 ± 0.14 LogMAR) ($p < 0.001$). Postoperative BCVA was also significantly superior in the toric IOL group (0.04 ± 0.05 vs 0.10 ± 0.08 ; $p = 0.002$). Residual refractive astigmatism was significantly lower in Group T (0.48 ± 0.27 D) than Group NT (1.36 ± 0.52 D) ($p < 0.001$). Spectacle independence was achieved in 82% of patients in the toric IOL group compared to 36% in the non-toric group. Postoperative complications were minimal and comparable between both groups.

Conclusion; Phacoemulsification with toric intraocular lens implantation provides superior visual and refractive outcomes compared to non-toric IOL implantation in patients with pre-existing corneal astigmatism. Toric IOLs significantly reduce residual astigmatism and improve spectacle independence with good safety and rotational stability.

Keywords: Cataract, Phacoemulsification, Toric intraocular lens, Non-toric intraocular lens, Corneal astigmatism, Visual outcome, Refractive outcome.

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INTRODUCTION

Cataract is one of the most common causes of avoidable blindness worldwide and contributes significantly to visual disability, especially among the elderly population. Advances in cataract surgery have transformed the procedure from simple cataract extraction to a refractive surgery aimed at achieving optimal postoperative visual quality and spectacle

independence. Phacoemulsification with intraocular lens (IOL) implantation has become the standard surgical technique because of its safety, rapid recovery, minimal postoperative complications, and predictable refractive outcomes.(1)

Pre-existing corneal astigmatism is frequently encountered in patients undergoing cataract surgery. Studies have shown that nearly 15–30% of cataract patients possess corneal astigmatism greater than 1.0 diopter, which can significantly compromise postoperative visual outcomes if not corrected during surgery.(2) Residual postoperative astigmatism may lead to blurred vision, reduced contrast sensitivity, glare, halos, and continued dependence on corrective spectacles.(3)

Various methods have been proposed for correcting astigmatism during cataract surgery, including limbal relaxing incisions, opposite clear corneal incisions, laser refractive procedures, and toric intraocular lens implantation. Among these techniques, toric intraocular lenses have emerged as one of the most effective and predictable methods for simultaneous correction of cataract and corneal astigmatism.(4)

Toric intraocular lenses are specially designed to neutralize pre-existing corneal astigmatism by incorporating cylindrical power into the lens optic. Accurate keratometric assessment, precise intraoperative axis alignment, and postoperative rotational stability are essential factors influencing successful refractive outcomes with toric IOLs.(5) Even minimal postoperative rotation may significantly decrease the effectiveness of astigmatic correction.

In contrast, implantation of non-toric intraocular lenses corrects only the spherical refractive component and leaves the pre-existing corneal astigmatism largely unaddressed. Consequently, patients receiving non-toric IOLs often require spectacles postoperatively to achieve satisfactory visual acuity.(6)

Several clinical studies have demonstrated superior visual and refractive outcomes with toric IOL implantation compared to non-toric IOLs. Patients implanted with toric lenses generally achieve better uncorrected visual acuity, lower residual refractive astigmatism, and higher levels of spectacle independence.(7,8) Furthermore, improvements in lens design and surgical techniques have enhanced rotational stability and long-term effectiveness of toric lenses.(9)

Despite increasing awareness regarding astigmatism correction during cataract surgery, limited comparative studies are available from Indian tertiary care centers evaluating toric and non-toric IOL implantation outcomes. Therefore, the present study was conducted to compare the visual and refractive outcomes following phacoemulsification with toric versus non-toric intraocular lens implantation in patients with pre-existing corneal astigmatism at PES Institute of Medical Sciences and Research.

MATERIALS AND METHODS

Study Design and Setting

This prospective comparative observational study was conducted in the Department of Ophthalmology at PES Institute of Medical Sciences and Research over a period of one year. The study aimed to evaluate and compare the visual and refractive outcomes following phacoemulsification with toric versus non-toric intraocular lens (IOL) implantation in patients with pre-existing corneal astigmatism undergoing cataract surgery.

Study Population

A total of 100 patients diagnosed with age-related cataract associated with pre-existing corneal astigmatism were included in the study. Patients attending the ophthalmology outpatient department and fulfilling the eligibility criteria during the study period were enrolled after obtaining informed written consent.

Group Allocation

The enrolled patients were divided into two groups comprising 50 patients each:

- Group T (Toric IOL Group): Patients undergoing phacoemulsification with toric intraocular lens implantation.
- Group NT (Non-Toric IOL Group): Patients undergoing phacoemulsification with non-toric intraocular lens implantation.

Inclusion Criteria

- Patients aged ≥ 40 years with senile cataract.
- Presence of regular pre-existing corneal astigmatism between 1.0 and 3.0 diopters.
- Patients willing to participate and provide informed consent.
- Clear cornea permitting adequate preoperative evaluation.

Exclusion Criteria

- Irregular corneal astigmatism.
- Corneal pathologies such as keratoconus, corneal opacity, or degeneration.

- Previous ocular surgery or trauma.
- Retinal diseases affecting visual prognosis.
- Glaucoma, uveitis, or optic nerve disorders.
- Intraoperative complications during cataract surgery.
- Patients are unwilling to follow up.

Preoperative Evaluation

All patients underwent a detailed ophthalmic examination, including:

- Best corrected visual acuity (BCVA) assessment using Snellen's chart.
- Uncorrected visual acuity (UCVA).
- Slit lamp biomicroscopy.
- Intraocular pressure measurement using Goldmann applanation tonometry.
- Dilated fundus examination.
- Keratometry and corneal topography for assessment of corneal astigmatism.
- Axial length measurement using optical biometry/A-scan biometry.
- IOL power calculation using standard formulas.

For patients in the toric IOL group, toric IOL power and alignment axis were calculated using manufacturer-specific toric calculators, considering surgically induced astigmatism.

Surgical Procedure

All surgeries were performed under aseptic precautions by experienced ophthalmic surgeons using the standard phacoemulsification technique under topical or peribulbar anaesthesia.

A clear corneal incision was made, followed by continuous curvilinear capsulorhexis, hydrodissection, phacoemulsification of the nucleus, cortical aspiration, and implantation of the intraocular lens into the capsular bag.

In Group T, toric intraocular lenses were aligned according to the predetermined corneal meridian using preoperative corneal marking techniques.

In Group NT, standard non-toric foldable posterior chamber intraocular lenses were implanted.

Postoperative medications included topical antibiotics, corticosteroids, and lubricants as per institutional protocol.

Follow-Up

Patients were followed postoperatively at:

- Day 1
- 1 week
- 1 month
- 3 months

At each follow-up visit, the following parameters were evaluated:

- Uncorrected visual acuity (UCVA)
- Best corrected visual acuity (BCVA)
- Residual refractive astigmatism
- Keratometric astigmatism
- IOL position and alignment
- Postoperative complications

Visual acuity was converted to logarithm of minimum angle of resolution (LogMAR) values for statistical analysis where applicable.

Outcome Measures

The primary outcome measures were:

- Postoperative uncorrected visual acuity.
- Residual refractive astigmatism.

Secondary outcome measures included:

- Best corrected visual acuity.
- Spectacle independence.
- Rotational stability of toric IOL.
- Postoperative complications.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software version 25.0. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were expressed as frequencies and percentages.

Comparison between the two groups was performed using:

- Independent Student's t-test for continuous variables.
- Chi-square test or Fisher's exact test for categorical variables.

A p-value of <0.05 was considered statistically significant

RESULTS AND OBSERVATIONS

A total of 100 patients with pre-existing corneal astigmatism undergoing cataract surgery were included in the study. Among them, 50 patients underwent phacoemulsification with toric intraocular lens implantation (Group T), and 50 patients underwent phacoemulsification with non-toric intraocular lens implantation (Group NT).

Table 1: Age Distribution of Study Participants

Age Group (Years)	Group T (n=50)	Group NT (n=50)	Total (n=100)
40-50	8 (16%)	7 (14%)	15 (15%)
51-60	14 (28%)	16 (32%)	30 (30%)
61-70	20 (40%)	18 (36%)	38 (38%)
>70	8 (16%)	9 (18%)	17 (17%)

The majority of the patients belonged to the 61-70 years age group in both study groups.

Table 2: Gender Distribution

Gender	Group T (n=50)	Group NT (n=50)	Total
Male	28 (56%)	30 (60%)	58 (58%)
Female	22 (44%)	20 (40%)	42 (42%)

Male patients constituted the majority in both groups.

Table 3: Preoperative Corneal Astigmatism

Corneal Astigmatism (Diopters)	Group T Mean \pm SD	Group NT Mean \pm SD	P value
Preoperative Astigmatism	1.92 \pm 0.54	1.88 \pm 0.49	0.71

There was no statistically significant difference in preoperative corneal astigmatism between the two groups.

Table 4: Comparison of Preoperative and Postoperative UCVA (LogMAR)

Visual Acuity	Group T Mean \pm SD	Group NT Mean \pm SD	P value
Preoperative UCVA	1.02 \pm 0.24	1.00 \pm 0.22	0.68
Postoperative UCVA (3 Months)	0.12 \pm 0.08	0.34 \pm 0.14	<0.001

Postoperative uncorrected visual acuity was significantly better in the toric IOL group compared to the non-toric IOL group.

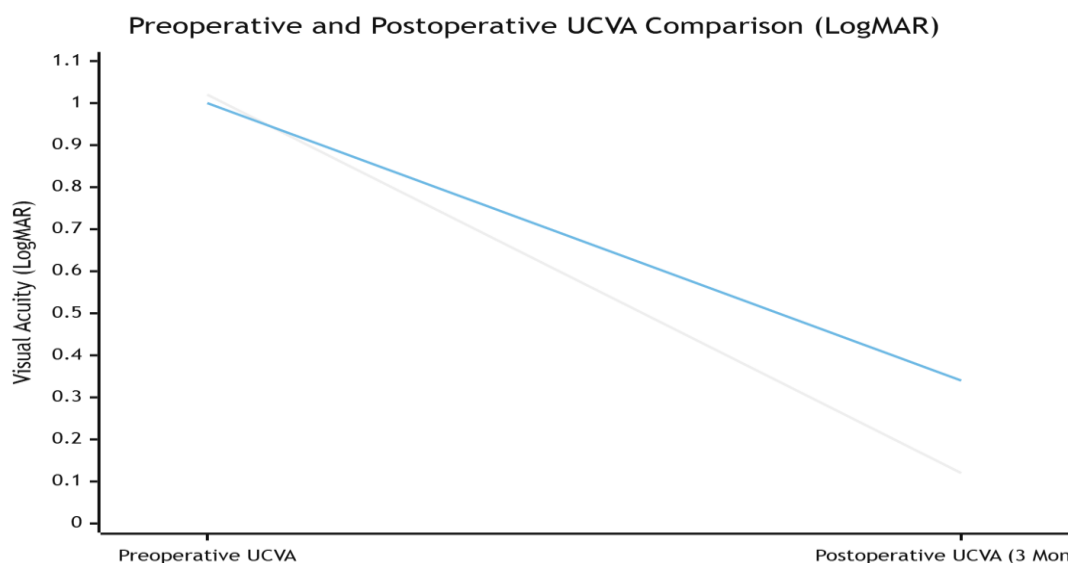


Table 5: Comparison of Best Corrected Visual Acuity (BCVA) at 3 Months

BCVA (LogMAR)	Group T Mean \pm SD	Group NT Mean \pm SD	P value
Postoperative BCVA	0.04 \pm 0.05	0.10 \pm 0.08	0.002

The toric IOL group showed significantly superior postoperative best corrected visual acuity.

Table 6: Residual Refractive Astigmatism at 3 Months

Residual Astigmatism (D)	Group T Mean \pm SD	Group NT Mean \pm SD	P value
Residual Refractive Astigmatism	0.48 \pm 0.27	1.36 \pm 0.52	<0.001

Residual postoperative astigmatism was significantly lower in patients implanted with toric IOLs.

Table 7: Distribution of Patients According to Postoperative Spectacle Dependence

Spectacle Dependence	Group T (n=50)	Group NT (n=50)	P value
Independent	41 (82%)	18 (36%)	<0.001
Dependent	9 (18%)	32 (64%)	

Spectacle independence was significantly higher among patients receiving toric IOL implantation.

Table 8: Rotational Stability of Toric IOL

Rotation of Toric IOL	Number of Patients (n=50)
<5° Rotation	42 (84%)
5°–10° Rotation	6 (12%)
>10° Rotation	2 (4%)

Most toric intraocular lenses demonstrated good rotational stability with less than 5° rotation.

Table 9: Postoperative Complications

Complication	Group T (n=50)	Group NT (n=50)	P value
Corneal Edema	3 (6%)	4 (8%)	0.69
Raised IOP	2 (4%)	3 (6%)	0.64
Posterior Capsular Opacification	1 (2%)	2 (4%)	0.55
Significant IOL Rotation	2 (4%)	—	—

Postoperative complications were minimal and comparable between both groups.

DISCUSSION

The present prospective comparative observational study evaluated and compared the visual and refractive outcomes following phacoemulsification with toric and non-toric intraocular lens implantation in patients with pre-existing corneal astigmatism. The findings of the study demonstrated that toric IOL implantation provided significantly superior postoperative visual and refractive outcomes compared to non-toric IOL implantation.

In the present study, the majority of patients belonged to the 61–70 years age group, with males constituting a slightly higher proportion of the study population. Similar demographic findings were reported by Mendicute et al., who observed that senile cataract associated with astigmatism predominantly affects the elderly population.(4)

Preoperative corneal astigmatism was comparable between the two groups, with no statistically significant difference observed. This ensured uniform baseline characteristics and enabled reliable comparison of postoperative outcomes. Similar baseline equivalence was reported in studies conducted by Bauer et al. and Ahmed et al.(7,8)

Postoperative uncorrected visual acuity (UCVA) at 3 months was significantly better in the toric IOL group compared to the non-toric IOL group. Patients implanted with toric IOLs achieved excellent unaided visual acuity due to simultaneous correction of spherical and cylindrical refractive errors. These findings are consistent with the observations of Ahmed et al., who reported significantly improved postoperative UCVA among patients receiving toric IOLs.(7)

The present study also demonstrated significantly superior postoperative best corrected visual acuity (BCVA) in the toric IOL group. Improved optical quality and reduction of residual astigmatism likely contributed to enhanced visual performance. Similar results were reported by Mendicute et al., who concluded that toric IOL implantation improves overall visual rehabilitation in cataract patients with corneal astigmatism.(4)

Residual refractive astigmatism was markedly lower in the toric IOL group compared to the non-toric IOL group. The mean residual astigmatism in the toric group was 0.48 \pm 0.27 D, whereas the non-toric group demonstrated significantly higher postoperative astigmatism. This finding highlights the effectiveness of toric IOLs in correcting corneal

astigmatism during cataract surgery. Bauer et al. similarly observed a substantial reduction in postoperative refractive cylinder with toric IOL implantation.(8)

Spectacle independence was significantly higher among patients receiving toric intraocular lenses. In the present study, 82% of patients in the toric IOL group achieved spectacle independence compared to only 36% in the non-toric group. This improved quality of vision and reduced dependence on corrective glasses contribute substantially to patient satisfaction following cataract surgery. Ahmed et al. also reported higher patient satisfaction and spectacle independence among toric IOL recipients.(7)

Rotational stability is a critical determinant of toric IOL effectiveness. In the present study, the majority of toric lenses demonstrated excellent rotational stability, with less than 5° rotation observed in 84% of patients. Only 4% of cases showed significant rotation greater than 10°. Similar findings were documented by Chang, who emphasized that modern toric IOL designs provide good postoperative rotational stability and consistent refractive outcomes.(9)

Postoperative complications in the present study were minimal and comparable between both groups. Mild corneal edema, transient rise in intraocular pressure, and posterior capsular opacification were the commonly observed complications. No sight-threatening complications were encountered. These findings are consistent with previous studies indicating that toric IOL implantation is a safe and reliable procedure.(5,7)

Overall, the findings of the present study suggest that toric intraocular lens implantation during phacoemulsification is an effective method for correcting pre-existing corneal astigmatism and achieving superior postoperative visual outcomes compared to non-toric IOL implantation. Toric IOLs significantly improve uncorrected visual acuity, reduce residual astigmatism, and enhance spectacle independence while maintaining excellent safety and rotational stability.

CONCLUSION

Phacoemulsification with toric intraocular lens implantation provides better visual and refractive outcomes than non-toric IOL implantation in patients with pre-existing corneal astigmatism. Toric IOLs significantly improve postoperative visual acuity, reduce residual astigmatism, and increase spectacle independence with good rotational stability and minimal complications. Therefore, toric IOL implantation is a safe and effective method for correcting corneal astigmatism during cataract surgery.

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