

Retrospective Case Series on The Enduring Rotational Stability of The AcrySof IQ Toric Intraocular Lens in Cataract Patients Suffering from Myopia

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Abstract: *Objective:* To analyze the enduring rotational steadiness of AcrySof IQ Toric intraocular lens (IOL) in cataract patients suffering from myopia in a long-term study. *Methods:* A retrospective study was conducted on a case series involving 78 patients. A total of 120 eyes with an axial length (AL) ranging from 24–30 mm and corneal astigmatism ≥ 1.50 D underwent implantation of AcrySof IQ Toric IOL guided by the version navigation system. The eyes were divided into two groups based on AL. Group A included 60 eyes with high myopia ($AL \geq 26$ mm), while Group B consisted of eyes with low to moderate myopia ($24 \text{ mm} \leq AL < 26 \text{ mm}$). Data on the preoperative AL were collected. Measurements were taken for residual astigmatism, the best corrected visual acuity (BCDVA), corneal astigmatism, and IOL rotation occurring between 24- and 48-months post-surgery. The percentage of eyes with an IOL rotation of under 5° and 10° was analyzed. *Results:* The mean length of follow-up times was recorded as 34.27 ± 4.98 , and the average rotation was $2.73 \pm 1.29^\circ$. Group A exhibited a slightly higher average rotation of $2.87 \pm 1.31^\circ$, compared to the rotation of $2.59 \pm 1.27^\circ$ observed in Group B. At both the 24–36 month and 26–48 month post-operation marks, the degree of IOL rotation did not show a statistically significant difference between the two groups, with none of the patients experiencing a rotation exceeding 10° ($P > 0.05$). The percentage of rotation degrees under 5° was recorded as 98.22%. After the procedure, the BCDVA was 0.13 ± 0.03 LogMAR. There was a substantial increase in the χ^2 value after the operation as compared to the pre-operative χ^2 value ($\chi^2 = 76.79$). The standard deviation of preoperative corneal astigmatism was statistically significant ($P < 0.05$) at 2.17 ± 1.08 D. Following the surgical procedure, the remaining astigmatism was measured at 0.41 ± 0.26 D. The data showed a notable gap in statistical significance ($t = 4.281$, $P < 0.05$). *Conclusion:* The AcrySof Toric IOL was a reliable solution for managing corneal astigmatism in cataract patients with myopia, demonstrating excellent long-term rotational stability.

Keywords: Astigmatism; Long-term; Myopia; Rotational stability

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1. Introduction

In modern times, cataract surgery has evolved to prioritize not only restoring sight but also enhancing refractive

outcomes, resulting in elevated expectations for visual acuity following the procedure. Astigmatism significantly impacts the overall clarity of one's vision. Studies have shown that between 15%–29% of cataract patients in the United States exhibit corneal astigmatism exceeding 1.50 D before operation. In China, 10.6%–12.4% of cataract patients had corneal astigmatism above 1.50 D before operation^[1]. The insertion of intraocular lenses (IOL) for correcting astigmatism was a successful method for enhancing the visual acuity of individuals with cataracts and corneal astigmatism^[2]. The AcrySof Toric IOL, a leading one-piece acrylic IOL manufactured by the renowned Alcon Company in the United States, is highly regarded for its safety and effectiveness in cataract surgery^[3–5].

As society evolves and people's habits change, the prevalence of myopia is increasing worldwide within the healthcare sector. The escalating rate of myopia poses a dire challenge in China. A global survey found that myopia affects 26.5% of the adult population, whereas 11.7% of adolescents experience myopia during their teenage years^[6,7]. The incidence of nearsightedness in Chinese teens surpasses the global average by a wide margin. The occurrence of myopia among Chinese teenagers is 80.7%, placing them at risk of experiencing axial myopia advancements in later years^[8]. The prognosis for a substantial portion of individuals receiving cataract surgery in the future is likely to be complicated by the presence of myopia. Research findings indicated that nearsightedness significantly contributes to the potential rotation of Toric IOL lenses^[9]. Currently, there is inadequate research on the long-term rotational stability of myopic individuals following the insertion of Toric IOLs. By utilizing the OPD-Scan corneal analyzer, this research retrospectively analyzed the stability of Toric IOL rotation in patients with different degrees of myopia and investigated the factors that may impact this stability.

2. Data and methods

2.1 General information

Criteria-based selection was conducted for patients who underwent phacoemulsification combined with AcrySof Toric IOL implantation at Daqing Oilfield General Hospital in Heilongjiang Province, China, between January 2017 and April 2019. Inclusion criteria: (1) lens opacity and nuclear hardness were Grade III (Emery nuclear hardness grading standard); (2) corneal astigmatism was consistent and had a degree of astigmatism ≥ 1.50 D; (3) eye axis > 24 mm; (4) patients with full preoperative information and underwent a follow-up examination 24–48 months after surgery. Exclusion criteria: (1) Patients with pre-existing eye conditions like trauma, keratoconus, glaucoma, macular degeneration, or retinopathy that impact the best-corrected distance visual acuity (BCDVA); (2) history of previous eye surgeries; (3) patients experiencing adverse events either during their surgery or in the period following the procedure; (4) patients enrolled in concurrent clinical studies or research trials. The patients who had lens capsular tension rings implanted underwent surgery only after signing the necessary consent forms and adhering to the ethical guidelines outlined in the Helsinki Declaration.

2.2. Research methods

2.2.1. Preoperative evaluation

The preoperative evaluation included standard procedures that were conducted before cataract surgery. Biometric values were measured where the optometrist utilized a Topcon comprehensive optometry instrument from Japan to measure the BCDVA of all patients before their surgery. At the same time, the IOL Master 700 from Zeiss in Germany was used to measure their axial length (AL), corneal astigmatism, and corneal curvature. In cases where the IOL Master 700 was unable to measure the axial length, a Super KR 8100 P from Topcon in Japan was employed.

2.2.2. Calculation of Toric IOL

The Toric IOL was calculated using the Haigis formula to determine the spherical diopter required for the lens. The calculation of the cylindrical diopter was determined using the Barrett formula. The corneal curvature was calculated using the AcrySof calculator. The incision placement and the impact on surgical astigmatism were taken into account by the surgical team throughout the operation. The AcrySof Toric IOL models T2 through T9 were chosen. The incision position for the operation was consistently chosen at 155°, resulting in the acquisition of the axial posture and estimated residual astigmatism. The level of astigmatism was adjusted to 0.30 D.

2.2.3. Preoperational procedures

Before surgery, the patient was placed in a seated position, while the slit lamp band was adjusted by the axis alignment marks for the surgical incision and the direction of the IOLs. The slit lamp was positioned at the center to mark the incision location and two marks were made along the axial direction of the IOLs.

2.2.4. Operation method

The operation was performed by the same surgeon to ensure that both groups underwent identical surgical methods. Following the instructions provided by the Verion navigation system, a transparent corneal cut was created and the capsulorhexis diameter was measured at 5.0–5.5 mm. Phacoemulsification surgery was carried out using the Centurion phacoemulsification device (Alcon, United States) to remove the cloudy lens. Following the successful insertion of the Toric IOL, precise rotational adjustments were made to align it to the specified axial position with the assistance of navigational guidance, ensuring optimal placement. The entire viscoelastic substance located between the Toric IOL and the back surface of the lens capsule was effectively removed. Before the incision was closed with water, the needle was gently pressed down. Following the surgical procedure, levofloxacin, propranolol, and dipyridamole eye drops were given, four times on one day a week for one month.

2.2.5. Post-operative care after eye surgery

The patient's general information was documented during follow-ups between 24–48 months post-operation, which included the assessment of intraocular pressure and the examination of the cornea, posterior lens capsule, and fundus using a slit lamp. The BCDVA was also dealt with and any residual astigmatism was corrected.

2.2.6. Measurement techniques for Toric IOL axial

The movement of Toric IOL over a 24- to 48-month period post-operation was measured. Firstly, the slit lamp measurement technique was utilized following full pupil dilation. The patients were instructed to position their head parallel to the slit lamp with the axis alignment mark. To measure and record the degree of Toric IOL alignment, the slit lamp band was aligned with the axis of the Toric IOL and the angle was documented using the slit lamp. The OPD-Scan measurement was performed by instructing the patient to focus on the cursor on the OPD-Scan III device following three blinks. The patient was then scheduled for a cataract removal the following week. Next, activate the initiation command. The measured values were continuously collected three times. Results revealed that the values appear to be related to a graphical representation showing the axial position of an IOL. To calculate the average value, the position of the red line was identified accurately.

NIDEK				Toric IOL Summary		2022/04/23 15:05	
ID	20220325003			Physician			
Name	Tangxiuying,			Technician			
ExamNo	1	Date	2022/03/25 10:00	Comment			
				Diagnosis			

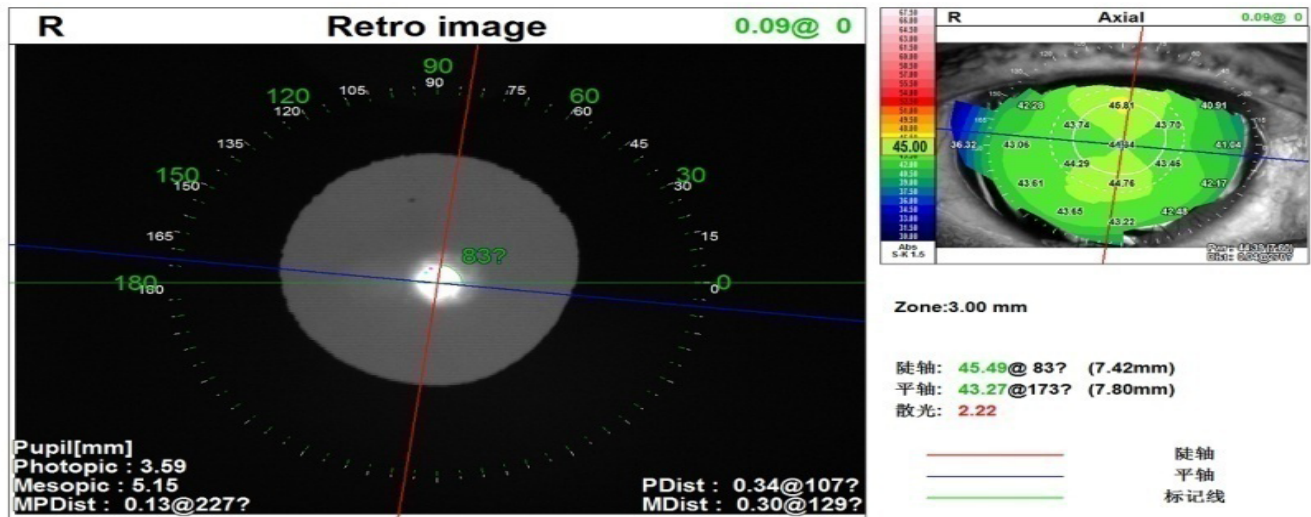


Figure 1. Utilizing the OPD scan to assess the axial positioning of Toric IOLs

As illustrated in **Figure 1**, this positioning is crucial for determining the effectiveness of the lens, and the degree of the Toric IOL was determined to be 83°.

2.2.7. Statistical analysis

Statistical analysis was carried out using the SPSS 22.0 software. Continuous variables were expressed as mean ± standard deviation and compared and analyzed using a *t*-test and chi-squared (χ^2) test. Results were considered statistically significant at $P < 0.05$.

3. Results

3.1. General situation

Throughout the observation period, none of the patients experienced any adverse events such as elevated intraocular pressure, infections, pupil abnormalities, macular swelling, or significant clouding of the posterior capsule. Additionally, the intraocular lens remained properly positioned within the capsular bag with optimal alignment.

3.2. Postoperative visual acuity

During the follow-up visit between 24–48 months post-operation, every patient achieved a long-distance visual acuity exceeding 0.5 LogMAR. Following the operation, there was a noticeable enhancement in visual acuity as opposed to the preoperative state, with a calculated statistical significance of $\chi^2 = 76.79$ ($P < 0.05$), as indicated in the data presented in **Table 1**. In Group A, following the operation, 37 eyes fell within 24–36 months, while 21 eyes fell within 36–48 months. There were 13 eyes with postoperative visual acuity greater than or equal to 0.6 LogMAR and 9 eyes with a visual acuity of 0.6 LogMAR or higher. There were no significant statistical differences ($\chi^2 = 8.32$, $P > 0.05$). In Group B, 29 eyes fell within the 24-36 months, while 13 eyes fell

within the 36-48 months. Among these, 8 eyes in the earlier months and 5 eyes in the following months had a postoperative visual acuity of ≥ 0.6 LogMAR. There were no significant statistical differences ($\chi^2 = 7.91$, $P > 0.05$).

Table 1. The BCDVA distribution before and after operation (%)

Group	Cases, <i>n</i>	>1.0 LogMAR	1.0–0.5 LogMAR	0.5–0.2 LogMAR	< 0.2 LogMAR
Preoperation	120	66 (55.00)	49 (48.83)	5 (4.17)	0 (0.00)
Group A	62	0 (0.00)	0 (0.00)	36 (58.06)	26 (41.94)
Group B	58	0 (0.00)	0 (0.00)	35 (60.34)	23 (39.66)
χ^2			76.79		
<i>P</i>			< 0.05		

3.3. Preoperative corneal astigmatism measurements during the refractive state

The average preoperative corneal astigmatism was 2.17 ± 1.08 D before the surgery. The remaining astigmatism at 24–48 months post-surgery was measured at 0.41 ± 0.26 D. The observed discrepancy yielded a significant *t*-value of 4.281 ($P < 0.05$). The astigmatism remaining after surgery for Group A patients was measured at 0.49 ± 0.24 D and 0.46 ± 0.23 D at 24–36 months and 36–48 months post-operation, respectively. This study's outcomes did not achieve statistical significance, as indicated by a *t*-score of 0.972 ($P > 0.05$). Measurement of residual astigmatism at different time points after surgery in group B showed little variation, measuring at 0.50 ± 0.29 D and 0.48 ± 0.26 D at 24–36 months and 36–48 months post-operation, respectively. The results were not statistically significant ($t = 1.026$, $P > 0.05$).

3.4. Postoperative IOL axial mobility

The postoperative axial mobility of IOLs was evaluated using slit lamp and OPD-Scan methods, showing similar results between patient samples. Ninety-nine eyes were found to exhibit IOL rotation. Two eyes had IOL axial mobility greater than 5° , with no significant difference between both methods for detecting IOL rotation ($P > 0.05$). Seventeen eyes (14.67%) rotated clockwise, while 82 eyes (68.33%) rotated counterclockwise. The degree of rotation in group A slightly exceeded that of group B. Out of the eyes observed, only 2 exhibited an IOL axial mobility exceeding 5° , with no statistically significant variance found between both methods of detecting IOL rotation ($P > 0.05$). Specifically, 17 eyes (14.67%) demonstrated clockwise rotation, while 82 eyes (68.33%) displayed counterclockwise rotation. It was noted that the degree of rotation in Group A marginally surpassed that of group B. There was no statistically significant difference in the accuracy of the OPD-Scan method for detecting Toric IOL rotation between the two groups at both the 24–36 month and 36–48-month post-surgery ($P > 0.05$). This is illustrated in **Table 2** and **Table 3**.

Table 2. The long-term rotational stability after Toric IOL implantation ($^\circ$)

Group	OPD-Scan III method	Slit lamp method	<i>t</i>	<i>P</i>
Group A	2.87 ± 1.27	2.85 ± 1.35	1.081	> 0.05
Group B	2.59 ± 1.31	2.52 ± 1.14	1.132	> 0.05
<i>t</i>	1.424	1.545		
<i>P</i>	> 0.05	> 0.05		

Table 3. The rotational stability at different time points after Toric IOL implantation (°)

Time	Group A	Group B	<i>t</i>	<i>P</i>
24–36 months after operation	2.79 ± 1.43	2.55 ± 1.19	1.352	> 0.05
36–48 months after operation	2.91 ± 1.55	2.61 ± 1.58	1.422	> 0.05
<i>t</i>	1.128	1.087		
<i>P</i>	> 0.05	> 0.05		

4. Discussion

The presence of astigmatism after cataract surgery significantly impacts one’s visual outcomes. Statistical data indicates that the presence of a mild astigmatism of 0.5–1.0 D, uncorrected visual acuity (UCDVA) of 0.2 LogMAR, astigmatism of 1.0–2.0 D, and UCDVA of 0.4 LogMAR, astigmatism of 2.0–3.0 D and UCDVA of 0.5–0.7 LogMAR will affect the vision of patients as a whole ^[10]. Numerous techniques are available for addressing corneal astigmatism during cataract surgery, including creating an incision on the steeper meridian of the cornea, performing a release incision on the opposite side, or utilizing a curved corneal incision assisted by femtosecond laser technology. Nevertheless, corneal release procedures exhibit unreliable predictability, are confined to a limited range of correction, and possesses a potential for regression. These can be influenced by variables including age, placement, and dimensions of the corneal incision, and thickness of the cornea. Merdicate *et al.* ^[11] discovered that the UCDA of patients who underwent Toric IOL implantation surpassed that of those who underwent limbal lysis operation.

Over the past few years, there has been a growing trend towards the close integration of cataract and refractive surgeries. By utilizing advanced ophthalmic technology like Pentacam, Orbscan, and OPD-Scan, the assessment of eye metrics has become more precise and thorough, leading to enhanced reliability in predicting outcomes for Toric IOL placement.

The Toric IOLs manufactured by Alcon, is an innovative one-piece design utilizing hydrophobic acrylate material with modified haptics and engineered on the Acrysof natural IOL design platform. The optical component measures 6 units in diameter, with a total length of 12.0 mm, a spherical power of +6.0–+34.0 D, and a cylindrical power of +1.0–+6.0 D. Due to its hydrophobic acrylate composition, it exhibits durable bonding, thereby improving the structural integrity of the capsular bag. The blue light-blocking effect on the macular of the fundus helps safeguard the macular region of the fundus ^[12,14].

The widespread acknowledgment of the clinical benefits of implanting Toric IOLs in cataract patients with corneal astigmatism underscores the importance of this treatment option. Nevertheless, individuals with severe nearsightedness often have a lax suspensory ligament of the lens due to the elongated AL and oversized capsular bag. Excessive rotation of the Toric IOL can result in the cylinder lens generating an incorrect diopter, thereby exacerbating astigmatism and causing a decline in visual acuity. As a result, caution is recommended when considering the use of Toric IOL in patients who have high levels of myopia. High myopia refers to severe nearsightedness. Toric IOLs are specialized intraocular lenses used to correct astigmatism in patients with cataracts. Capsular tension rings are used to help stabilize the capsular bag in the eye during cataract surgery. Corneal astigmatism is a condition where the cornea is irregularly shaped, leading to distorted vision. The observation time refers to the duration during which the outcomes of a treatment are monitored ^[15].

Visual acuity was measured following surgery. The measurement of diopter and IOL rotation is a

standard practice for assessing the effectiveness of Toric IOL surgery^[16-17]. Within the scope of the research, the effectiveness of IOL in correcting corneal astigmatism in patients with high myopia and cataracts was demonstrated over a 24–48-month follow-up period. The mean BCDVA was recorded as 0.13 ± 0.03 logMAR. The residual astigmatism was found to be 0.41 ± 0.26 D in patients who underwent Toric IOL implantation, indicating an effective correction of corneal astigmatism. Based on the OPD-Scan III examination results, it was proven that Toric IOLs exhibited a positive impact on astigmatism correction. The stability of the Toric IOL's rotation was excellent, allowing for accurate and consistent astigmatism correction. The average rotational degree was found to be $2.73 \pm 1.29^\circ$. When comparing rotational degrees between the different myopia groups, the angular deviation among patients in the high myopia group was $2.87 \pm 1.31^\circ$, which was slightly higher than that recorded among patients in the middle and low myopia groups at $2.59 \pm 1.27^\circ$. However, the disparity between the two categories did not have any statistical relevance ($P > 0.05$). This suggests that the rotational stability of the Toric IOL was consistent. However, the degree of rotation was not significantly different between the two groups at 24–36 months and 36–48 months post-surgery ($P > 0.05$). The findings of this research aligned with the outcomes of the brief-term clinical investigation on Toric IOL^[18-20].

The effective centering and rotational stability of AcrySof Toric IOL could potentially be attributed to the innovative design of its stable force haptics, ensuring optimal alignment within the lens capsule. The excellent adherence of its hydrophobic material ensures consistent contact with the posterior capsule, effectively preventing lens rotation within the capsule^[21,22].

5. Conclusion

Following an analysis of 120 eyes over a 2- to 4-year period, it has been verified that AcrySof Toric IOL effectively addresses corneal astigmatism in cataract patients with myopia and demonstrates reliable long-term rotational stability.

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Disclosure statement

The authors declare no conflict of interest.

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