Clinical Ophthalmology

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ORIGINAL RESEARCH

Repositioning Rates of Toric IOLs Implanted in Cataract Surgery Patients: A Retrospective Chart Review

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Purpose: To determine the incidence of postoperative repositioning of toric intraocular lenses (IOLs) due to clinically significant rotation.

Patients and Methods: This study included consecutive cataract patients with pre-existing astigmatism who had undergone cataract surgery with toric IOL implantation by a single experienced surgeon. Case records of patients who were recommended to undergo toric IOL repositioning surgery due to clinically significant postoperative IOL rotation from the implanted axis were identified. The need for a secondary intervention to manage residual astigmatism was based upon postoperative residual astigmatic error ≥0.75 D, the patient's qualitative dissatisfaction with the level of postoperative distance vision, dilated post-op examination, and confirmation of the significant potential for astigmatism reduction.

Results: Case records of 993 eyes implanted with AcrySof toric (N = 362), Tecnis Toric I (N = 53), Tecnis Toric II (N = 308), or enVista Toric IOLs (N = 270) were included. Postoperative toric IOL repositioning was recommended in 16 eyes (1.6%). The repositioning rate was highest in the eyes implanted with Tecnis Toric I (5.7%), followed by AcrySof Toric (2.2%), enVista Toric IOLs (1.1%), and Tecnis Toric II (0.6%).

Conclusion: This real-world analysis of eyes implanted with toric IOLs revealed that the rate of surgical IOL repositioning due to clinically significant IOL rotation was lower than 2% for enVista and Tecnis Toric II IOLs. When needed and with appropriate planning, toric IOL repositioning can be very successful.

Keywords: Toric IOLs, astigmatism, IOL rotation, IOL repositioning, rotational stability

Introduction

Implantation of a toric intraocular lens (IOL) is a well-established method for correcting astigmatism at the time of cataract surgery. To achieve the desired postoperative visual acuity, the axis of astigmatism must be accurately determined preoperatively, the toric IOL must be precisely aligned intraoperatively, and it must remain on the intended axis postoperatively. For every degree of toric IOL misalignment, there is an approximately 3.3% loss of astigmatism correction; a toric IOL misalignment of 10° causes ~33% loss of the toric correction, and a 30° misalignment can result in a complete loss of the astigmatic correction.[1]

Among various factors, postoperative rotation is the most important contributor to toric IOL misalignment.[2] Maximum rotation of toric IOLs occurs in the early postoperative period, usually within the first few hours of cataract surgery, and very little rotation occurs after 1 week postoperatively.[2,3] Various modifiable and non-modifiable risk factors, including incomplete removal of ophthalmic viscosurgical devices; decentered, non-circular, or unusually large capsulorhexis; longer axial length/high myopia; larger capsular bag size; and fluctuations in intraocular pressure, have been found to be associated with an increased likelihood of toric IOL rotation.[4–7] IOL manufacturers have introduced a variety of innovations in IOL material and design to improve postoperative IOL stability and prevent IOL rotation even in the presence of risk factors.

Received: 22 September 2023
Accepted: 14 December 2023
Published: 23 December 2023

Significant toric IOL rotation may still occur and result in residual astigmatism postoperatively, unsatisfactory visual acuity outcomes, and patient dissatisfaction, necessitating surgical intervention to reposition the toric IOL. The aim of this real-world retrospective study was to determine the repositioning rates of contemporary toric IOLs due to clinically significant rotation.

Materials and Methods

This retrospective study included consecutive cataract patients with pre-existing astigmatism who had undergone toric IOL implantation between January 2018 and December 2022. The study was performed in accordance with the tenets of the Declaration of Helsinki and its amendments and was approved by Salus IRB (Austin, Texas, United States) with a waiver of informed consent as the data were recorded in patient charts as a part of routine clinical practice, and only de-identified patient data were analyzed.

As a part of routine clinical practice, the decision to implant toric IOLs in patients with regular astigmatism was based on biometry measurements obtained from four different devices: iTrace (Tracey Technologies Corp., Houston, TX, USA); TMS-2N corneal topography instrument (Tomey Technology, Nagoya, Japan); Pentacam Scheimpflug imaging system (Oculus Optikgeräte GmbH, Wetzlar, Germany) and Lenstar LS 900 (Haag-Streit AG, Switzerland). In patients with pre-existing dry eye disease (DED), appropriate treatment was administered to optimize the ocular surface and biometric measurements were repeated until minimal fluctuation in keratometry was detected to ensure the stability of measurements.

The toric IOL power and the axis of implantation were calculated using the Barrett toric calculator tool provided by the American Society of Cataract and Refractive Surgery. The intended axis was marked carefully using corneal ink marks and, when needed on occasion, re-marked to ensure accuracy. At the end of the surgery, after wound hydration, the patient was asked to look into the microscope, and toric IOL alignment on the intended axis was reconfirmed.

All toric IOL procedures performed by a single, experienced surgeon (EH) during the study period at Illinois Eye Center in Peoria, IL, and Wolfe Eye Clinic in Cedar Rapids, IA, were evaluated. The operating surgeon had over a decade of experience in toric IOL implantations before the initiation of the study period. The need for a secondary intervention to manage residual astigmatism was based upon postoperative residual astigmatic error ≥0.75 D, the patient's qualitative dissatisfaction with their postoperative distance vision, dilated post-op examination, and confirmation of significant potential for visual improvement based on the toric enhancement software integrated with iTrace ray-tracing aberrometry and/or www.AstigmatismFix.com analysis. The iTrace system determines the orientation of the toric IOL based on internal ocular aberrations. Its toric IOL enhancement software provides the degree of misalignment of the toric IOL and the direction and magnitude of suggested repositioning to achieve optimal results.[8] The www.Astigmatismfix.com website uses the patient's postoperative manifest refraction and IOL cylinder power and orientation to determine the ideal location for the IOL and estimated refraction when the IOL axis is repositioned to that location.[9]

Case records of patients for whom toric IOL repositioning surgery was recommended were retrospectively reviewed.

Outcome measures included the percentage of eyes in which IOL repositioning surgery was recommended and/or performed for residual astigmatism due to toric IOL rotation; repositioning rates stratified by IOL type; and comparison of visual and refractive outcomes before and after repositioning surgery.

Statistical Analysis

Data analysis was performed using Microsoft Excel and SPSS software (version 27.0) for Windows (IBM SPSS Statistics 27, IBM Inc., Armonk, NY). Descriptive statistics on categorical data included frequencies and percentages and mean and standard deviation (SD) for continuous data. All p-values were two-sided and were considered statistically significant when less than 0.05.

Results

This retrospective study evaluated 993 eyes that underwent cataract surgery with the implantation of toric IOLs from various lens platforms including AcrySof Toric (Alcon Laboratories, Fort Worth, TX, USA; N = 362); Tecnis Toric

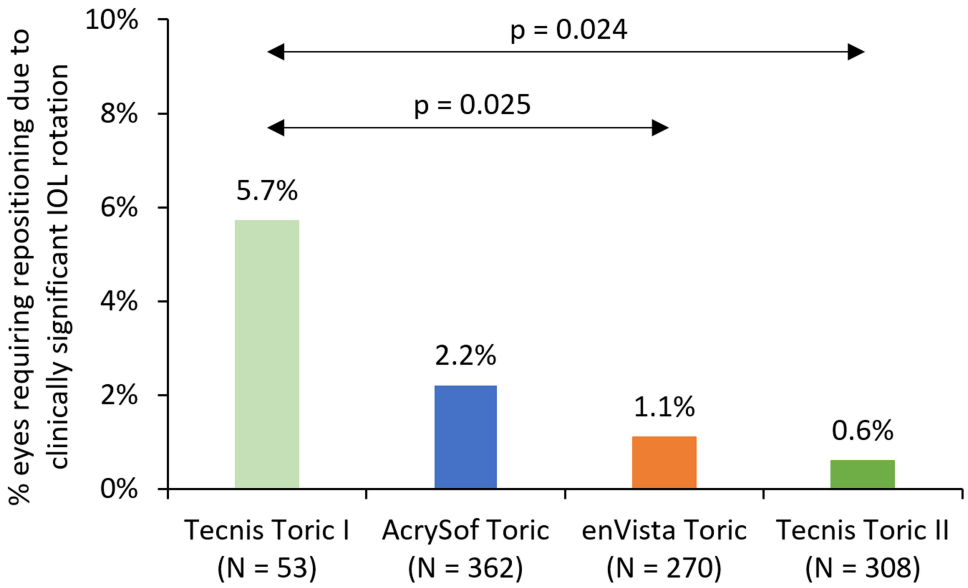

Figure 1 Proportion of eyes that underwent toric IOL repositioning due to clinically significant IOL rotation postoperatively (Statistically significant p-values are displayed; other comparisons had p>0.05 and are not displayed).

I (Johnson & Johnson Vision, Irvine, CA, USA; N = 53); Tecnis Toric II (Johnson & Johnson Vision, Irvine, CA, USA; N = 308) and enVista Toric (Bausch + Lomb, Rochester, NY, USA; N = 270). Of the 993 cases, toric IOL repositioning due to toric IOL rotation was recommended in 16 eyes (1.61%). None of the eyes had misalignment due to incorrect selection of toric IOL. The mean preoperative manifest refraction spherical equivalent in these 16 eyes was −2.99 ± 2.78 D (range −10.38 to 1.50).

Among these 16 eyes, the IOL repositioning rate was highest among eyes implanted with the Tecnis Toric I IOL (5.7%), followed by AcrySof Toric IOL (2.2%), enVista (1.1%) and Tecnis Toric II (0.6%) (Figure 1). Of the 16 eyes requiring surgical reintervention, there was one eye in which IOL repositioning was not possible due to capsular fibrosis, and the patient declined to undergo laser vision enhancement to correct the residual astigmatism. No eye needed an IOL exchange.

Among the 15 eyes that underwent IOL repositioning, mean refractive astigmatism improved from 1.53 ± 0.71 D prior to rotation to 0.21 ± 0.24 D at week 1 after repositioning, with 93% of the eyes achieving visual acuity of 20/25 or better postoperatively. Detailed case-by-case results are presented in Table 1.

Discussion

This study evaluated the repositioning rates of toric IOLs in a real-world clinical practice setting. It demonstrates that, among all contemporary toric IOLs, clinically significant rotation is uncommon, with Tecnis Toric II and enVista Toric platforms yielding the lowest rates of repositioning.

The risk of IOL rotation for the studied lens platforms has been compared previously.[10,11] Garzon et al compared the rotational stability of enVista and AcrySof toric IOLs and reported better rotational stability with enVista toric IOLs (with 90.5% eyes showing IOL rotation ≤5° versus 64.3% of those implanted with AcrySof toric IOL).[11] Schartmuller et al compared the non-toric IOLs from these platforms and reported better rotational stability with AcrySof (95.2% of AcrySof eyes had IOL rotation ≤5° compared to 92.5% of Tecnis Toric I and 86.1% of enVista MX60 lenses).[10] In a large series, Lee and Chang reported that 91.9% of AcrySof eyes had IOL rotation ≤5° compared to 81.8% of Tecnis Toric I eyes, although visual acuity results were equivalent between the two groups.[12]

While measurement of mean postoperative IOL rotation is a vital piece of information, the risk of clinically significant IOL rotation necessitating postoperative IOL repositioning may be more valuable for surgeons. In previous studies, the original Tecnis Toric I platform was found to have higher repositioning rates than the AcrySof

https://doi.org/10.2147/OPTH.S441524 DovePress

Table 1 Relevant Pre-Cataract Surgery, Pre- and Post- IOL Rotation Characteristics of the 16 Eyes That Had Clinically Significant IOL Rotation

IOL Implanted		Laterality	Preoperative Manifest Refraction	Target Axis as Determined by Barrett Toric IOL Calculator (Pre-Cataract Surgery)	Outcomes at Postop Week 1 After Cataract Surgery (Prior to Toric IOL Repositioning Surgery)			The Need for Toric IOL Rotation as Analyzed by		Amount and Direction of IOL Rotation	Outcomes at Postop Week 1 Following IOL Repositioning Surgery	
IOL Model	IOL Power				Manifest Refraction	Visual Acuity	IOL Axis	Itrace	Astigmatism fix.com		Manifest Refraction	Visual Acuity
MX60ET	14.5	OS	−3.00–2.00x015	153	0.50–2.25x174	20/50	113	39 CCW	50 CCW	45 CCW	−0.25–0.25x002	20/20
MX60ET	19	OS	−2.50–3.25x175	47	0.50–3.00x006	20/60	20	48 CCW	59 CCW	**Not rotated due to capsular fibrosis**		
MX60T2.75	13	OS	−3.25–3.25x010	107	0.75–2.50x035	20/30	78	22 CCW	27 CCW	25 CCW	−0.25–0.50x180	20/25+
SA6AT3	19.5	OD	0.75–1.75x015	104	1.25–2.25x015	20/50	42	56 CCW	50 CCW	53 CCW	0.50–0.50x035	20/25
SA6AT4	18.5	OD	0.75–1.50x090	4	0.50–1.00x075	20/25+	20	54 CW	13 CW	15 CW	0.50–0.50x078	20/20
SA6AT4	12	OS	−4.25–2.00x010	104	0.75–1.25x045	20/50	75	29 CCW	25 CCW	27 CCW	0.25 sph	20/20
SA6AT4	19.5	OS	−0.25–1.75x080	174	−0.25–0.75x030	20/60	5	19 CW	14 CW	14 CW	−1.00 sph	20/100
SA6AT6	21	OS	0.50–4.00x095	179	+1.25–2.00x065	20/40	NA	22 CW	18 CW	20 CW	Plano	20/20
SA6AT9	16	OD	0.75–6.00x010	100	1.50–2.75x155	20/60	115	14 CW	18 CW	16 CW	Plano-0.25x020	20/20
TFAT30	13	OS	−4.00–1.25x150	153	0.50–1.25x150	20/40	145	44 CW	66 CW	50 CW	**Tech did not refract**	20/25
TFAT40	16.5	OD	−1.25–2.25x010	91	1.00–2.00x020	20/70	55	51 CCW	33 CCW	40 CCW	Plano-0.50x055	20/20
ZCU225	15.5	OS	−3.50–1.50x177	107	0.25–1.00x135	20/50	117	20 CW	19 CW	20 CW	Plano-0.50x145	20/20
ZCU225	19.5	OD	−0.75–1.75x005	105	Plano-0.75x165	20/40	114	14 CW	12 CW	13 CW	Plano	20/20
ZXT225	20.5	OD	2.50–2.00x010	114	Plano-1.50x150	20/50	123	17 CW	31 CW	25 CW	Plano	20/20
ZXT225	16.5	OS	−2.50–0.75x070	174	0.25–0.50x060	20/30	10	30 CW	8 CW	20 CW	Plano	20/20
ZXT375	7.5	OS	−9.75–1.25x010	97	0.75–1.25x127	20/60	115	16 CW	12CW	15 CW	Plano	20/20

Abbreviations: CW, clockwise; CCW, counterclockwise; NA, not available in the file.

platform.[12–14] Our study also found higher repositioning rates with Tecnis Toric I (5.7%) than the AcrySof (2.2%). High myopia is considered to be one of the risk factors for toric IOL rotation. In the present study, only one patient who underwent Tecnis toric I IOL implantation had high myopia of −10.38 D prior to cataract surgery. Patients who underwent implantation of other IOL types had mild to moderate myopia. There are no previous reports in the literature of risk of IOL repositioning due to clinically significant IOL rotation with Tecnis Toric II or enVista IOL platforms; in the present study, we found that both these IOL have very low repositioning rates of 0.6% and 1.1%, respectively.

Toric IOL manufacturers have taken a variety of approaches to minimize the postoperative rotation of their lenses. The enVista IOL is designed to provide a large contact angle between its haptics and the capsular bag. This broad 110° contact angle is complemented by a high haptic compression force, which increases the stability of the IOL within the capsular bag.[15] AcrySof IOLs are known to be made of a very "tacky" material that contributes to their good rotational stability.[12,16–20]

The Tecnis Toric II platform was designed to improve upon its predecessor with frosted haptics, which offers more surface texture and friction between the lens haptics and the capsular bag. IOL haptics with more surface texture has been documented to offer better rotational stability, probably due to the higher frictional coefficient.[21–23] The frosted haptics may also expedite IOL unfolding, with earlier and greater contact between the haptics and the capsular bag equator reducing the risk of the incomplete unfolding of the haptics at the end of surgery.[23] A recent prospective study validated that mean absolute lens rotation was 0.94° ± 0.71° and that postoperative rotation was ≤5° in 100% of eyes 3 months after implantation of IOLs with the newer toric design.[24] The statistically significantly lower repositioning rate of the Tecnis Toric II vs the Tecnis Toric I IOLs in the present study corroborates this and other findings of a very low rate of rotation with the newer lens platform.[3,23,24]

While it is important to choose a toric IOL with a low risk of rotation, clinically significant IOL rotation may occur with any IOL. It is important to be prepared to reposition the lens when required. Both methods used by the author to plan for repositioning, the iTrace toric enhancement software and www.AstigmatismFix.com, have been documented to improve outcomes after IOL repositioning. In the present study, if the magnitude of required postoperative repositioning was different between the two methods, the surgeon used the middle value and achieved good results. In the author's opinion, both www.AstigmatismFix.com and iTrace toric enhancement software work well to determine the degree and direction of IOL repositioning needed.

This retrospective study provides insights into the real-world probability of clinically significant IOL rotation requiring repositioning. The retrospective data also have some inherent disadvantages. While all care was taken to ensure precise alignment of the IOL on the intended axis, some IOL misalignment due to incorrect intraoperative alignment may have occurred. Inoue et al have demonstrated that IOL misalignment due to postoperative IOL rotation is a much larger (2.6 times higher) contributor to misalignment than incorrect intraoperative alignment. Although not studied separately, clinically significant toric IOL misalignment necessitating IOL repositioning is more likely due to postoperative IOL rotation than incorrect alignment.

Conclusion

In conclusion, the rate of clinically significant toric IOL rotation requiring IOL repositioning is low for all IOL platforms. However, in the present study, toric IOL of Tecnis II platform showed the least IOL rotation rates corresponding to only 0.6%. Both www.AstigmatismFix.com and iTrace toric enhancement software work well to determine the degree and direction of IOL repositioning when needed to correct residual astigmatism.

Abbreviations

IOLs, intraocular lenses; SD, standard deviation; DED, dry eye disease.

Data Sharing Statement

The data used to support the findings of this study are included within the article. Clarifications or additional data used to support the findings of this study may be requested from the corresponding author.

Acknowledgments

Jan Beiting (Wordsmith Consulting) and Raman Bedi, MD (IrisARC – Analytics, Research & Consulting) assisted with statistical analysis and preparation of this manuscript.

Partial results of this paper were presented at the 2022 ASCRS Annual Meeting.

Funding

Funding for this study was provided by Johnson & Johnson Vision.

Disclosure

EH is a consultant for Alcon, Bausch + Lomb, and Johnson & Johnson Vision.

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