

Influence of axial length on Toric IOL rotational stability - a retrospective study.

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I. Introduction

Toric intraocular lens (IOL) implantation during cataract surgery should result in less spectacle dependence postoperatively in patients with pre existing corneal astigmatism. However, precise alignment of the cylindrical axis of the toric IOL with the astigmatic axis of the cornea is the key to success. Imprecise alignment results in residual astigmatism with an axis different from that before surgery. In cases of significant misalignment, it can result in higher astigmatism than preoperatively as well as flipping of the orientation of the axis of astigmatism in the entire eye.

Shah G et al in their prospective observational study evaluated the rotational stability of Acrysof toric intraocular lens (IOL) using purpose designed software and determined the influence of axial length (AL) and in-the-bag IOL alignment on IOL rotation.^[1] They assessed the efficacy of their software in evaluating the influence of Axial Length (AL) and axis of toricity on IOL rotation under standardized settings. They detected significant IOL movement at each follow-up and a correlation between AL and rotational stability (ie, greater rotation in myopic eyes). The maximum rotation in myopic eyes was 3 degrees. They found a correlation between a high AL and 3-degree rotation of toric IOLs. However it is uncertain whether the 1 to 3 degrees of postoperative rotation was clinically significant as none of the toric IOLs required repositioning post surgery.

In a previous study, by Chang 3 of 263 IOLs rotated more than 15 degrees off axis and required surgical repositioning. He suggested that the high degree of rotation in these 3 cases might be attributed to the high level of myopia in the eyes Chang.^[2] found significant misalignment within the first 24 hours postoperatively in 6 consecutive myopic patients. In a consecutive series of 100 cases, the same author reported excellent rotational stability of the Acrysof toric IOL; the mean IOL rotation was 3.3 +/- 3.4 degrees.^[3] He also suggested that significant postoperative rotation of the Acrysof toric IOL is rare. In the same study, 90% of the IOLs were aligned within +/-5 degrees of the intended axis and 99% of IOLs within +/-10 degrees and no IOL required surgical repositioning.

Ruhswurm et al.^[4] evaluated the rotational stability of 1-piece plate-haptic silicone toric IOLs. They measured IOL rotation in 5-degree steps and found that an increase in AL was associated with greater IOL rotation- in his preliminary experience with shorter toric IOLs.

It has been suggested that large-diameter capsular bags might be associated with a reduction in the equatorial friction for a given IOL and therefore a decrease in IOL stability.^[5] Studies show that capsular bag diameter tends to correlate with an increase in AL.^[6-8] Thus, early rotation is more likely to occur in highly myopic eyes.

We believe that the relative accuracy of the conventional method of evaluating postoperative IOL orientation through a dilated slit lamp examination is subject to the observer's experience, bias and has inherent precision limits. Also most of the above studies have recorded clinically insignificant degrees of rotation with increased axial length. Hence in this study we want to document the axial length influence in patients who have clinically significant rotated toric IOL reporting in the post operative period after uneventful surgery requiring repositioning .Also 5 different toric IOLs models were compared.

II. Methods

This was a retrospective, non-randomised, clinical study conducted at department of phacoemulsification and refractive surgery at Nethradhama Superspeciality Eye Hospital, Jayanagar, Bangalore India. It included male / female patients who had undergone uneventful phacoemulsification with toric IOL implantation from Jan 2012 till Jan 2014. This study was approved by the local ethics committee.

Inclusion criteria for the study was- corneal astigmatism more than 1.0 diopter (D) measured by partial coherence interferometry (PCI) (IOLMaster, Carl Zeiss Meditec), presence of cataract, adequate pupil dilation to visualize the innermost toric axis marks at all follow-ups, at least 1 prominent episcleral vessel around the

limbus to act as a reference mark for aligning all follow-up images, total capsulorhexis coverage of the IOL optic.

Exclusion criteria were -irregular astigmatism , presence of forme fruste keratoconus on corneal tomography using Scheimpflug scanning- slit imaging device (Pentacam HR), difference in astigmatism axis between the PCI keratometry reading (K) and the simulated K reading axes of tomography of more than 10.0 degrees, corneal scarring, phacodonesis, pseudoexfoliation syndrome, traumatic cataract, any ophthalmic pathology that could have a significant impact on postoperative visual function ,history of ocular surgery, patients with intraoperative complications such as wound-site thermal injury, incisions requiring suturing, posterior capsule rupture, and descemet membrane detachment, were also excluded from the final analysis.

All the patients preoperatively had a routine slit lamp examination with pupils completely dilated. Axial length was measured using optical coherence interferometry (IOL Master, Carl Zeiss Meditec AG).Corneal astigmatism was determined by keratometry (IOL Master, Carl Zeiss Meditec AG) and by Pentacam. The spherical power of the IOL was then calculated using the SRK/T formula, targeting emmetropia. The cylindrical power and the axis of toric IOL placement were calculated using an online calculator provided by the respective IOL manufacturer of the Intraocular Lens

For preoperative corneal marking, the eye was anesthetized with a single drop of proparacaine 0.5%. The horizontal meridian was marked with the patient sitting at the slitlamp and the patient's chin positioned on the chinrest and patient was asked to fixate straight ahead on a distant target with the nonsurgical eye. The slit beam was positioned in the retroillumination position and the slit oriented horizontally. Small superficial markings were made using a corneal marker pen on the limbus at the 3 o'clock and 9 o'clock positions. Care was taken to center the slit beam on the center of the pupil for alignment. Finally, the surgeon verified the correct position at the slitlamp

All the surgeries were performed using topical anesthesia, phacoemulsification, and a standardized technique. A temporal 2.8 mm clear corneal incision (CCI) was made for all patients. After coaxial irrigation/ aspiration was performed, the capsular bag was filled with viscoelastic. The axis of IOL placement was marked with a Villasenor-Navarro degree gauge and a toric axis marker (AE-2740 Nuijts toric axis marker, American Surgical Instruments Corp.).

The IOL was implanted in the capsular bag. As a first step, the IOL was rotated into a position approximately 10 degrees short of the actual marked axis of placement. The residual ophthalmic viscosurgical device (OVD) was removed from behind the IOL and the anterior chamber.

Finally, the IOL was rotated to align the peripheral dots on the IOL with the marked steep meridian on the cornea. The anterior chamber was reformed, and stromal hydration of the main and paracentesis incisions was performed. Correct alignment of the IOL was verified at the end of surgery.

The patients were examined at one day, two weeks, at 1month, 3 months and 6 months after surgery.

Intraocular lens rotation and assessment of digital retroillumination images which were captured at baseline (within 24 hours of surgery) and 2 weeks, 1 month, and 3 months and 6 months postoperatively was done using a digital zoom camera mounted on slitlamp. The same observer captured and analyzed the images at all follow-up visit. Using I-trace HOYA designed software the degree of rotation was calculated.

III. Results

The study included 221 eyes (119 right and 102 left). Total of 5 toric IOL models were used in the study (78 Acrysof, 54 Rayner, 49 Zeiss , 33 Tecnis 1 , 7 Restor multifocal) .Out of the 221 toric IOLs implanted only 6 had clinically significant rotation requiring repositioning. The remaining 215 toric IOLs had a mean axial length of 23.9mm and had a rotation of +/- 4 degrees measured by I trace software shown in figure 1. Total of 6 toric IOLs required repositioning (3- Zeiss, 2 Rayner, 1 Tecnis, 0-Acrysof, 0 Restor) depicted in graph 1 .The axial length of 5 of the 6 IOLs (80%) was > 24mm, having a range of 23.1 to 25.4mm.The mean axial length of the IOLs requiring repositioning was 24.5mm.

The axial lengths of the eyes implanted with toric IOLs for each model which had an axial length of above 24mm is shown in graph 2. The number of eyes having an axial length > 24mm which had Zeiss IOLs implanted were 16 out of which 3 required repositioning, out of the 24 eyes implanted with Rayner IOL 2 required repositioning and 10 of the Tecnis 1 IOLs implanted only 1 required repositioning. Of the 41 Acrysof IOLs implanted with axial length >24mm, none required repositioning

The spherical power of all the IOL requiring repositioning were < 20D ranging from + 12.5 to +19 D which is depicted in table 1

The Hoya I-trace software measures in degrees the amount of clockwise rotation required to realign the IOL with its intended axis of placement as depicted in figure 2. The degrees of clockwise rotation required to realign is calculated and mentioned in the below table ranging from 24 degrees to 110 degrees

All the IOLs rotation occurred within post operative day 1 to day 15 follow up visit.

IV. Discussion

The use of toric IOLs to correct corneal astigmatism is sometimes complicated by rotation of the IOL in the capsular bag.^[9] Rotation occurs in the early postoperative period, before the anterior and posterior leaves of the capsule fuse. The presence of long axial length which translates to large capsular bag size may result in undesirable postoperative IOL rotation. The other mechanisms include incomplete OVD clearance, which causes reduced friction between the haptics and the capsular bag,^[10] and early postoperative IOP fluctuations; both are linked to rotational instability. Capsulorhexis size, IOL design and material are other influencing factors.^[11] With time, postoperative capsule shrinkage compresses the IOL haptics and may cause rotation of IOLs of certain designs and materials.

In the present study, we attempted to evaluate the influence of axial length on IOL rotation under standardized settings. We detected significant IOL movement at each follow-up and a correlation between AL and rotational stability (ie, greater rotation in myopic eyes). The IOL's requiring repositioning were taken up immediately for surgery. Repositioning was done by injecting balanced salt solution to inflate the bag without using OVD. The patients were then re examined for documentation of rotation.

In a previous study, by Dr Chang, the author suggests that the high degree of rotation in toric IOLs might be attributed to the high level of myopia^[2]. In a consecutive series of 100 cases, the same author^[3] reported excellent rotational stability of the Acrysof toric IOL; the mean IOL rotation was 3.3 +/- 3.4 degrees. He also suggested that significant postoperative rotation of the Acrysof toric IOL is rare. The findings in this current study agree with those previously reported in the literature.

It has been suggested that large-diameter capsular bags might be associated with a reduction in the equatorial friction for a given IOL and therefore a decrease in IOL stability.^[12] Studies show that capsular bag diameter tends to correlate with an increase in AL.^[13-15] Thus, early rotation is more likely to occur in highly myopic eyes. Patel et al.^[16] used serial digital photography to compare rotation between plate-haptic IOLs and loop-haptic IOLs. They found a significant correlation between an increase in AL and IOL rotation with the plate-haptic IOLs but not with the loop haptic IOLs. This difference was because they used a 3-piece silicone loop-haptic IOL with a haptic diameter of 13.5 mm. This can be attributed to the use of a 3-piece loop-haptic acrylic IOL with a longer haptic diameter (13.5 mm). Furthermore, the authors did not specify the range of AL in the eyes in their study; this is a crucial, factor for determining capsular bag size in these cases.

The Hoya I Trace software (toric planner) used in the study showed reproducible readings and was accurate when post repositioning refractive errors were analysed. This software as displayed in the figure below gives in degrees the amount of clockwise rotation required for aligning the axis of IOL. The dotted yellow toric marking indicates the misalignment from the axis. The solid yellow mark is the required axis of placement. The Zaldivar callipers help in aligning the axis 0-90degrees axis and can be adjusted real time depending on the 0-180 degrees marking done on slit lamp incise there exist a parallax.

The event of rotation of a toric IOL is rare (p=.296) by independent t test and hence not clinically significant as only 6 of the toric IOLs rotated out of 221 implanted in our study. But there is a higher chance of rotation of the IOLs requiring repositioning if the axial length is >24mm as per our study. Even though one IOL had axial length of 23.1mm the keratometric reading were of the order 43.1 and 45.9 resulting in an IOL power of +19.0D indicating a myopic eye. All the IOL requiring repositioning had powers in the range of 12.5 to 19.0D indicating myopic eyes We found a higher incidence of rotation among the plate haptic toric IOLs (Zeiss) this was mainly due to the IOL design and relatively lesser overall diameter of the IOL- 11.0 mm as compared to the other IOLs in the study as indicated in the table 2.

A similar result was obtained by Ruhsurm et al.^[4] in his study of 1-piece plate-haptic silicone toric IOLs. This clearly indicates that IOL design and overall diameter play an important role in stability of the IOL.

The use of I Trace software not only helps in standardisation of measurements it also helps in counselling of patients post operatively. As most of the rotation occurred from the period of day 1 to day 15 post op in our study, hence IOLs which were stable after 1 month were unlikely to rotate. It would be safe to predict positive postoperative outcomes with the use of our software. Moreover, in patients with high myopia, the surgeon must exercise caution when calculating IOL power, marking the IOL, and implanting it because of the large capsule size. The unavailability of larger diameter Toric IOLs to compensate for large capsular bags just adds to the surgeon's woe.

In conclusion, greater rotation was observed in eyes with longer axial lengths, although the event of a toric intraocular lens requiring repositioning is not significant clinically. Plate haptic intra ocular lenses have a higher chance of rotation due to their design..

The use of Hoya I Trace software was accurate and easy to use, providing precise toric intra ocular lens rotation measurements.

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Tables

Table-1 Summary of toric IOLs requiring repositioning

No	IOL	Axial length	K1	K2	Spherical IOL power	Degree Of Rotation*
1	Rayner	24.30	42.35	46.30	15.0	110
2	Rayner	23.12	43.10	45.92	19.0	24
3	Zeiss	24.68	41.87	46.42	13.5	90
4	Zeiss	24.54	42.83	47.54	12.5	60
5	Zeiss	25.37	41.62	44.58	16.0	34
6	Tecnis 1	25.36	45.18	46.87	12.5	55

*Clockwise – as measured by Hoya i Trace software

Table- 2 Toric IOLs used in study

Toric IOL	Material	Design	Overall diameter mm	Optic diameter mm
Acrysof IQ	Acrylic, hydrophobic	One piece open loop	13	6
Restor	Acrylic, hydrophobic, multifocal	One piece open loop	13	6
Rayner T flex 573T	Hydrophilic acrylic	One piece one piece closed loop	12	5.75
Zeiss	Hydrophilic acrylic (25 %)	One piece, bi toric	11	6
Torbi	With hydrophobic surface	Plate haptics		
Tecnis T	Acrylic, hydrophobic	One piece open loop	13	6

Graph legends

Graph-1 Toric IOLs categorised according to axial length

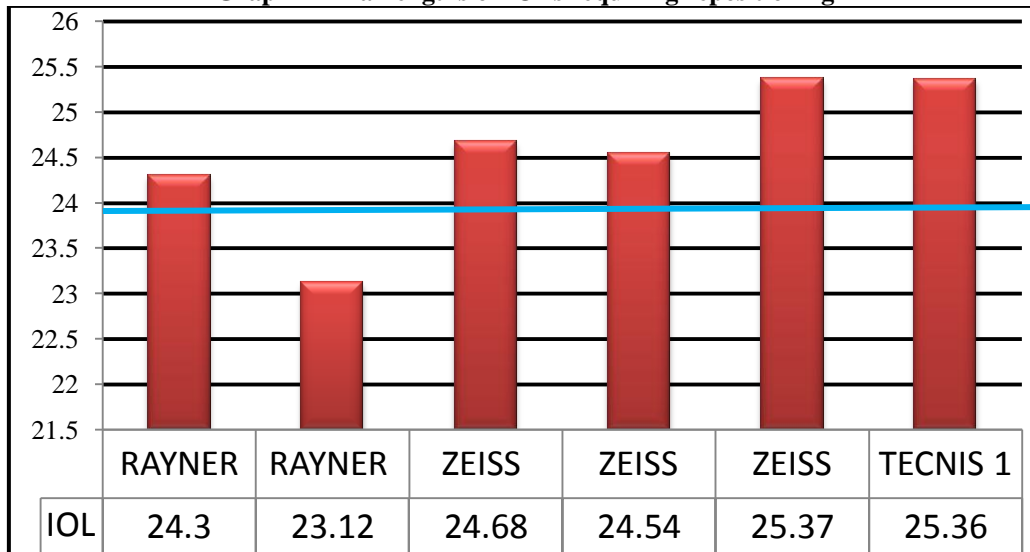
Graph-2 Axial lengths of IOLs requiring repositioning

Figure legends

Figure-1-Showing 4 degrees of rotation calculated by the Hoya I trace software

Figure-2- Toric IOL requiring 34 degrees of clockwise rotation for realignment

Graph-1 Axial lengths of IOLs requiring repositioning



Graph 2-Toric IOLs categorised according to axial length

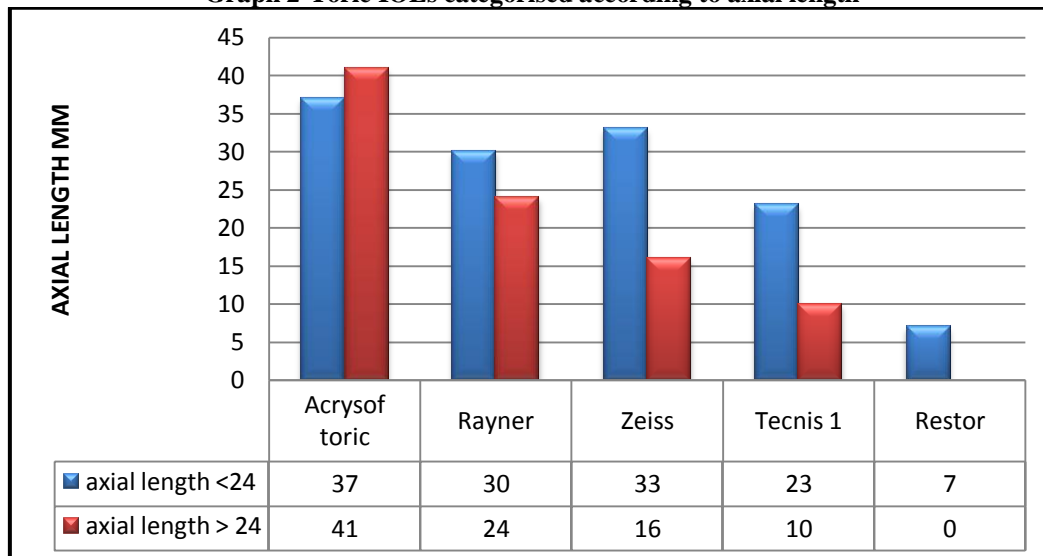


Fig-1-showing 4 degrees of rotation calculated by the Hoya I trace software

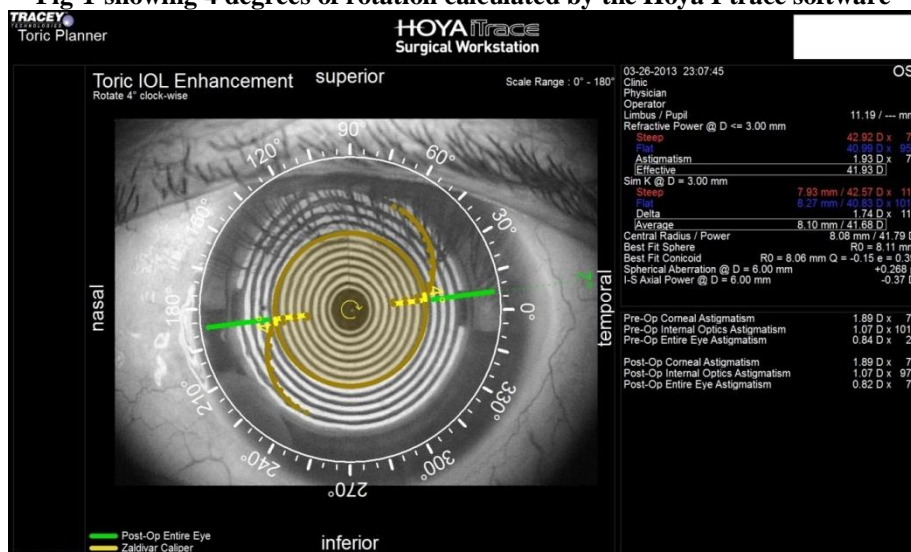


Figure-2 Toric IOL requiring 34 degrees of clockwise rotation for realignment

