

# Improving Refractive Outcomes Of Toric Intraocular Lens Implantation For Correction Of Astigmatism During Cataract Surgery.

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## ABSTRACT

**Objectives:** To evaluate whether updating corneal topography instrumentation and educating surgeons on optimum patient selection can result in improved toric IOL outcome.

**Methods:** A retrospective file review of patients who underwent cataract extraction and toric IOL placement over four years, between July 2010 and March 2014, at Lahey Clinic Medical Center, USA, was conducted. The patients were divided into two groups: group 1, those who had surgery between July 2010 and June 2012 and group 2 those who had surgery between July 2012 and March 2014 and the final uncorrected distance visual acuity (UDVA) outcome was compared. Corneal topography was obtained preoperatively on all patients - prior to June 2012, Nidek and Tomey topographers were primarily used, and after July 2012 Zeiss topographers were primarily used. In mid-2012, all surgeons in the department were educated on proper interpretation of topographic maps and instructed to avoid toric IOL placement if irregular astigmatism or ocular comorbidities limiting vision were present preoperatively. Uncorrected distance visual acuity and residual refractive astigmatism were noted at the 1-month postoperative visit. Data were sorted into 3 groups – Group 1, are those with good outcomes (UDVA 20/25 or better with 0.5 D or less of residual astigmatism), group 2, are those with fair outcomes (UDVA 20/30 or better with 0.75 or less of residual astigmatism), and group 3 are those with suboptimal outcomes (UDVA 20/40 or worse with 0.75 D or more of residual astigmatism).

**Results:** One hundred and thirty-three eyes of 96 patients (55 males, 41 females) were assessed between July 2010 and June 2012 (pre-intervention), and 115 eyes of 81 patients (55 males, 26 females) were assessed between July 2012 and March 2014 (post-intervention). The age range was 50-75 years with an average of 62.5 years. In the pre-intervention group, 72.9% of eyes had good or fair outcomes and 27% had suboptimal outcomes. In the post-intervention group, 75.7% of eyes had good or fair outcomes and 24.3% had suboptimal outcomes. Of the eyes with suboptimal outcomes, ocular comorbidities were present in 50% pre-intervention and in 23% post-intervention.

**Conclusions:** Despite reduction of toric IOL placement in patients with ocular comorbidities and irregular astigmatism, there was no significant decrease in the rate of suboptimal outcomes after toric IOL placement. This suggests that other factors may be more important to address, such as improving accuracy of axis marking and alignment.

**Keywords:** Corneal Topography, Toric IOL, Visual Acuity.

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## Introduction

Toric intraocular lenses (IOL) were developed to correct corneal astigmatism and to achieve a satisfactory spectacle independence following cataract surgery.<sup>(1)</sup> Initially previous toric IOL were associated with poor rotational stability and induction of astigmatism. The problem was solved with Acrysof IQ toric IOL (Alcon laboratories) which is associated with much better rotational stability, this was attributed to lens design and biomaterials from which it is made.<sup>(2,3)</sup> It is of equal importance to accurately detect the amount and the axis of corneal astigmatism, that is why many instruments were used and compared to measure the corneal astigmatism. This type of IOL, calculated on the formula SN60AT (Alcon Inc) design, is made of a single piece hydrophobic acrylic lens. Its posterior surface has cylinder power and axis marks to allow positioning at the exact axis in the bag. The range of IOL cylinder power is from 1.50–6.00 D of astigmatism in 0.75 D increment, the correction range at the corneal level is 0.75-4.00 D at the corneal level. Before surgery, it is essential to measure the degree and steepness of astigmatism. The new introduction of many methods including manual keratometry, automated keratometry, IOL Master Device (Carl Zeiss Meditec AG), added an additional dimension to optical analysis. The new method of OPD Scan II aberrometer (Nidek Co Ltd, Gamagori, Japan) gather both corneal topography and total eye wave front to measure the refractive and optical effects of the aberrations of the eye. Both measurements can be separated or combined to determine the effect of corneal aberrations and internal aberrations. It is important to determine whether astigmatism is usual regular corneal astigmatism or due to the internal optics of the eye before doing cataract surgery. This study was conducted to evaluate whether updating corneal topography instrumentation and educating surgeons on optimum patient selection can result in improved toric IOL outcome.

## Methods:

A retrospective file review of patients who underwent cataract extraction and toric IOL placement over four years, between July 2010 and March 2014, at Lahey Clinic Medical Center, USA, was conducted. The patients were divided into two groups: group 1, those who had surgery between July 2010 and June 2012 and group 2 those who had surgery between July 2012 and March 2014 and the final uncorrected distance visual acuity (UDVA) outcome was compared. Corneal topography was obtained preoperatively on all patients - prior to June 2012, Nidek and Tomey topographers were primarily used, and after July 2012 Zeiss topographers were primarily used. In mid-2012, all surgeons in the department were educated on proper interpretation of topographic maps and instructed to avoid toric IOL placement if irregular astigmatism or ocular comorbidities limiting vision were present preoperatively. Uncorrected distance visual acuity and residual refractive astigmatism were noted at the 1-month postoperative visit. Data were sorted into 3 groups – Group 1, are those with good outcomes (UDVA 20/25 or better with 0.5 D or less of residual astigmatism), group 2, are those with fair outcomes (UDVA 20/30 or better with 0.75 or less of residual astigmatism), and group 3 are those with suboptimal outcomes (UDVA 20/40 or worse with 0.75 D or more of residual astigmatism). Patients with incomplete data were excluded. This study was approved by the Ethical Committee of Lahey Clinic Medical Center and by the institutional review boards (IRB) before initiation of the study. Subjects or their parents or guardians provided written informed consent. The clinical trial conformed to the tenets of the Declaration of Helsinki. Simple statistics analysis was used such percentage, range, and mean.

## Results:

One hundred and thirty-three eyes of 96 patients (55 males, 41 females) were assessed between July 2010 and June 2012 (pre-intervention), and 115 eyes of 81 patients (55 males, 26 females) were assessed between July 2012 and March 2014 (post-intervention). The

age range was 50-75 years with an average of 62.5 years. In the pre-intervention group, 72.9% of eyes had good or fair outcomes and 27% had suboptimal outcomes, Table I. In the post-intervention group, 75.7% of eyes had good or

fair outcomes and 24.3% had suboptimal outcomes, Table II. Of the eyes with suboptimal outcomes, ocular comorbidities were present in 50% pre-intervention and in 23% post-intervention, Table III.

**Table I:** Mean postoperative UDVA in each outcome category pre-intervention group.

	<b>Good (n = 75) 56.4%</b>	<b>Fair (n = 22) 16.5%</b>	<b>Suboptimal (n = 36) 27.1%</b>
<b>Postoperative UDVA</b>	20/22	20/28	20/44
<b>Mean Residual Astigmatism (D)</b>	0.14 ± 0.22	0.38 ± 0.33	0.79 ± 0.31

**Table II:** Mean postoperative UDVA in each outcome category post-intervention group.

	<b>Good (n = 65) 56.5%</b>	<b>Fair (n = 22) 19.1%</b>	<b>Suboptimal (n = 28) 24.3%</b>
<b>Postoperative UDVA</b>	20/21	20/28	20/65
<b>Mean Residual Astigmatism (D)</b>	0.15 ± 0.22	0.56 ± 0.19	0.69 ± 0.46

**Table III:** Ocular comorbidities present in pre and post operative groups

	<b>Pre intervention group (n=18)</b>	<b>Post intervention group (n= 7)</b>
Preexisting medical condition affecting macula (DM, ARMD, epi-retinal membrane)	33.3%	28.9%
Preexisting medical condition affecting optic nerve ( glaucoma, optic neuropathy)	16.7%	14.1%
Irregular and asymmetric astigmatism ( keratoconus, ABMD)	23.3%	43%
Intraoperative complications (ruptured posterior capsule, weak zonules)	5.6%	0
Weak zonules (e. g pseudo-exfoliation)	11.1%	14%
Previous refractive surgery	10%	0

## Discussion:

Today's cataract surgery is also refractive surgery, so we are looking at uncorrected visual acuity and not only best corrected visual acuity to assess the quality of surgery. Moderate corneal astigmatism (1.5 D TO 3.0 D) is present in 14% of eyes, whereas high astigmatism is present in 2.6%.<sup>(4)</sup> There are many ways to correct preexisting astigmatism during cataract surgery; the options include limbal relaxing incisions opposite to clear corneal incisions. Unfortunately this may result in inducing

irregular astigmatism, abnormal wound healing and poor predictability.<sup>(3)</sup> Another method is excimer laser surgery. The problem is the cost issue and resulting corneal surface changes.<sup>(4)</sup> Toric intraocular lenses were developed to correct the preexisting regular astigmatism.<sup>(5)</sup> Toric IOL outcome depend on multiple factors: 1. corneal astigmatism, 2. toric IOL calculators 3. choosing residual astigmatic target 4. proper IOL alignment and centration, and 5. Managing unexpected outcomes of residual astigmatism and higher order aberrations.<sup>(6)</sup> Toric IOL calculators take into consideration surgically

induced astigmatism (SIA), and effective lens position (ELP).<sup>(5)</sup> It is always important to choose the toric IOL that achieves the lowest residual astigmatism to attain the best uncorrected vision regardless of the axis. Toric IOL's can rotate, small amount of rotation can be of small effect, but rotation of 30 degrees will eliminate the effect of toric IOL.<sup>(7)</sup> The postoperative visual acuity is usually checked in standard consultation room illumination (i.e., photopic conditions). But the advantage of the toric IOL may be more noticeable if measured under mesopic/scotopic conditions, where small differences in residual refractive astigmatism may result in more obvious change in vision quality as pupil size increases.<sup>(8)</sup> Astigmatism affects the quality of vision for distance as well as for near vision, although a small amount of with the rule astigmatism might improve near vision.<sup>(8)</sup> Topography and tomography do a much better job compared to manual or automated kerato-meter that was used in the past. Rather than four points on a ring, thousands of points are measured within a 3 mm to 4.5 mm zone and a torus or toric ellipsoid is used to perform a least squares of fit of the surface to all of the measured points.<sup>(9,10,11)</sup>

Corneal astigmatism is made partly from the anterior and posterior corneal surface. The axis changes with age from a with-the-rule astigmatism to against-the-rule astigmatism with age; the change is more contributed by the anterior corneal curvature. Although the contributions from the posterior corneal curvature are small, they are significant and this can be an important cause for astigmatic refractive errors after Toric IOL implantation.<sup>(7)</sup> The back surface of the cornea is negative and contributes 10% or less to the net corneal power.<sup>(5)</sup> It is important to exclude any eye with ocular pathology other than visually significant cataract (age related macular degeneration, optic disc atrophy, glaucoma, diabetic retinopathy, and amblyopia). There are many ways to mark the cornea before astigmatism reducing surgery (marking the horizontal axis using insulin needle at slitlamp,

pendular marker, a bubble marker and to no meter marking), some studies showed that the pendular marker showed the least rotational deviation to the reference meridian.<sup>(6)</sup> There are many methods to measure the preexisting corneal astigmatism. Manual keratometry, automated keratometry, IOL Master Device (Carl Zeiss Meditec AG), they are all based on keratometry.<sup>(9,10)</sup> Other methods are based on corneal topography and include Orbscan scanning-slit topography (Bausch and Lomb), the pentacam scheimpflug imaging system (Occlus), there are multiple studies reporting the accuracy of calculating toric IOL power using several of these techniques.<sup>(11)</sup> Multiple studies proved that the corneal astigmatism measurements from auto-keratometry, IOL Master, corneal topography scheimpflug imaging were comparable to this from manual keratometry which is considered as the golden method and can be used interchangeably with manual keratometry to measure corneal astigmatism.<sup>(9-14)</sup> One of the most important factors that can determine the success of toric IOL surgery is making sure that the preoperative measurements are correct. We cannot plan a toric IOL surgery based solely on the auto-keratometry feature of one instrument. Patient should have a visually significant cataract and astigmatism. A good candidate will be interested in spectacle independence even if only for one distance (usually far). It should be made clear to the patient that lenticular correction will be required for other distances (typically near and intermediate). Realistic expectations on the patient's part make for a successful outcome. The toric lenses currently available are designed to correct regular corneal astigmatism. Patients with irregular astigmatism will not benefit as well, so patient selection is a very important issue to be addressed. Ocular comorbidities should be ruled out before deciding to proceed with toric IOL placement, such as medical conditions affecting macula and/or optic nerve, weak zonules (e.g pseudo-exfoliation), irregular or asymmetric astigmatism such as anterior basement membrane dystrophy, keratoconus, corneal

scars, intraoperative complications such as zonular dehiscence, or torn posterior capsule. Surgeons' education about proper case selection resulted in significant decrease of Toric IOL placement in cases of ocular comorbidities. Limitations of the study: the study was a retrospective study rather than a prospective one, the follow up period was relatively short (one month follow up after surgery).The study did not compare the different types of Toric IOLs, and did not compare the surgical experience of the different surgeons.

### Conclusion:

Despite reduction of toric IOL placement in patients with ocular comorbidities and irregular astigmatism, there was no significant decrease in the rate of suboptimal outcomes after toric IOL placement ( $p < 0.001$ ). This suggests that other factors may be more important to address, such as improving accuracy of axis marking and alignment.

### References:

1. **Shimizu K, Misawa A, Suzuki Y.** Toric intraocular lenses: correcting astigmatism while correcting axis shift. *J Cataract Refract Surg* 1994; 20:523-526.
2. **De Silva DJ, Ramkissoon YD, Bloom PA.** Evaluation of a toric intraocular lens with a Z-haptic. *J cataract Refract Surg* 2006; 32:1492-1498.
3. **Sun X-Y, Vicary D, Montgomery P, Griffiths M.** Toric intraocular lenses for correcting astigmatism in 130 eyes. *Ophthalmology* 2000; 107:1781-1782.
4. **Hoffman PC, Auel S, Hutz WW.** Results of higher power toric intraocular lens implantation. *J Cataract and Refractive surgery* 2011;37: 1411-1418.
5. **Jack T.** Improving toric IOL outcomes. Holladay, *ocular surgery news US edition June*10, 2011.
6. **Popp N, Hirnschall N, Maedel S, Findl O.** Evaluation of 4 corneal

- astigmatic marking methods, *J Cataract and refractive surgery* 2012;38(12):2094-2099.
7. **Kessel L, Andresen J, Tendal B, Erngaard D, et al.** Toric Intraocular Lenses in the Correction of Astigmatism During Cataract Surgery: A Systematic Review and Meta-analysis. *Ophthalmology*. 2016;123(2):275-286.
8. **Aujla JS, Vincent SJ, White S, Panchapakesan J.** Cataract Surgery in Eyes with Low Corneal Astigmatism: Implantation of the Acrysof IQ Toric SN6AT2 Intraocular Lens. *J Ophthalmic Vis Res* 2014;9:324-328.
9. **Novis C.** Astigmatism and toric intraocular lenses. *Curr Opin ophthalmol* 2000; 11:47-50.
10. **Holland E, Lane S, Horn JD, Ernst P, Arleo R, Miller KM.** The Acrysoftoric intraocular lens in subjects with cataracts and corneal astigmatism; a randomized, subject-masked parallel group, 1-year study. *Ophthalmology* 2010; 117:2104-2111.
11. **Lee H, Chung JL, Kim EK, Sgrignoli B, Kim T.** Univariate and Bivariate polar value analysis of corneal astigmatism measurements obtained with 6 instruments. *J Cataract and refractive surgery* 2012; 38: 1608-1615, 2012 ASCRS and ESCRS.
12. **Alio JL, Pinero DP, Tomas J, Plaza AB.** Vector analysis of astigmatic changes after cataract surgery with implantation of a new toric multifocal intraocular lens. 2011;36(10):1700-1708.
13. **Chang DF.** Comparative rotational stability of single-piece open-loop acrylic and plate-haptic silicone toric intraocular lenses. *J Cataract Refract Surg* 2008; 34:1842-1847.
14. **Darzhikova A, Shah CR, Gimbel HV.** Early experience with Acrysoftoric IOL for the correction of astigmatism in cataract surgery. *Can J Ophthalmol* 2009; 44:269-273.