

# Correcting Astigmatism with Acrysof Toric Lenses (SN60T3 to SN60T9) in Cataract Surgery

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## Abstract

**Purpose:** The objective of this study was to evaluate the outcome of Acrysof Toric intraocular lenses (IOLs) implantation in cataract surgery for the correction of regular corneal astigmatism.

**Methods:** Twenty eyes of 16 patients with cataract and regular corneal astigmatism of 1.00-4.00 diopter (D) underwent surgery. Depending on the amount of corneal astigmatism, an Acrysof Toric IOL of type SN60T3, SN60T4, SN60T5, SN60T6, SN60T7, SN60T8 or SN60T9 was implanted. Studied parameters before and after surgery included uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), residual refractive astigmatism, change in corneal astigmatism, IOL rotation, and spectacle independence for distance vision.

**Results:** At six months after surgery, all eyes (100%) had a UCVA of  $^{20}/_{32}$  or better and 80% had a UCVA of  $^{20}/_{25}$  or better. Spectacle independence for distance vision was 85% in the studied eyes. The change in corneal astigmatism ranged between 0.25 and 0.5 D in all eyes. The residual astigmatism was 0.75 D or less in 100% of the cases and 0.0 to 0.5 D in 90% of the eyes. IOL rotation was zero degrees in 65% of the eyes, 4° or less in 90% of the eyes, and 5° or more in 10% of the eyes by six months after surgery.

**Conclusion:** Using Acrysof Toric IOLs (SN60T3 to SN60T9) during cataract surgery for patients who have regular corneal astigmatism of 1.0 to 4.0 D is an effective, predictable, and rather stable option for correcting astigmatism.

**Keywords:** Astigmatism, Cataract, Acrysof Toric Lens

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## Introduction

Advances in cataract surgery have made it recognizable as a refractive surgery procedure. Among candidates for cataract surgery, 15-29% have regular corneal astigmatism of 1.5 diopter (D) or more,<sup>1-3</sup> which is necessary to correct to meet increased patients' expectation for acquiring a desirable vision and freedom from spectacles after cataract surgery.

Currently, methods of correcting corneal astigmatism include incisional approaches such as limbal relaxing incisions (LRI)<sup>4,5</sup> and arcuate keratotomy (AK), laser approaches such as photorefractive keratectomy (PRK) and laser in situ keratomileusis (LASIK), and use of toric intraocular lenses (IOLs) in the posterior chamber.

Incisional methods are unpredictable and allow limited correction, and the disadvantages of laser approaches include higher costs and a frequent need for reoperation. Toric IOLs, however, can be used in cataract surgery and a number of studies

have evaluated the outcomes of using different types of toric IOLs.<sup>6-15</sup>

Toric lenses have different types; one of them is the Acrysof Toric IOL which is an acrylic one piece lens with an optical diameter of 6.0 mm and overall length of 13.0 mm. The toricity of this type of IOL has been applied to its posterior surface. This lens has marks near the haptic/optic junction to represent the flat meridian of the IOL and should align with the steep meridian of the cornea. Currently, a variety of Acrysof Toric lenses including SN60T3, SN60T4, SN60T5, SN60T6, SN60T7, SN60T8 and SN60T9 are available which are capable of correcting different levels of corneal astigmatism from 1.0 to 4.0 D (Table 1).

The correction range of Acrysof Toric lenses has expanded to over 4.0 D of corneal astigmatism with the introduction of the new SN60T6 to SN60T9. The aim of this study was to evaluate the outcome of using Acrysof Toric lenses to correct astigmatism in patients undergoing cataract surgery.

**Table 1.** Different types of Acrysof toric intraocular lenses

Acrysof Toric Intraocular Lenses	Astigmatism (D) (at the Intraocular Lenses plane)	Astigmatism (D) (at the corneal plane)
SN60T3	1.50	1.03
SN60T4	2.25	1.55
SN60T5	3.00	2.06
SN60T6	3.75	2.57
SN60T7	4.50	3.08
SN60T8	5.25	3.60
SN60T9	6.00	4.11

## Methods

In this study, we investigated 20 eyes of 16 patients undergoing cataract surgery and Acrysof Toric lens implantation from December 2009 to April 2010.

Inclusion criteria consisted of regular corneal astigmatism of 1.0 to 4.0 D, pupil dilation of at least 6.0 mm, and no history of glaucoma, retinal tear, macular degeneration, corneal diseases, neuro-ophthalmologic

disease, or intraocular inflammation. Corneal topography was done for all patients. Based on routine criteria, none of them had Keratoconus or Forme Fruste keratoconus (FFKCN).

An informed written consent was obtained from each patient prior to the surgery.

Ophthalmologic examinations included uncorrected visual acuity (UCVA), best

corrected visual acuity (BCVA), refraction, the slit-lamp exam, intraocular pressure (IOP) measurement, keratometry, topography (EyeSys 3000 Corneal Analysis System, EyeSys) and IOL Master (Zeiss Humphrey IOL Master, Carl Zeiss Meditec, Germany), and the type of Acrysof Toric was determined using the Acrysof Toric calculator available at [www.AcrysofToriccalculator.com](http://www.AcrysofToriccalculator.com).

All surgeries in this study were done by phacoemulsification using topical anesthesia by one experienced surgeon (HH). Preoperatively, corneal marking was done under local anesthesia with the patient sitting at the slit-lamp and the head in a vertical position. A narrow beam of light was horizontally projected from the slit-lamp to pass the geometrical center of the cornea to determine 0-180 degree meridian. Then, the light was projected vertically to determine the vertical meridian. In this way, the limbus was marked at 3, 9, and 12-o'clock positions. Then, after the patient lay down on the surgical table, the Mendez ring was used to determine and mark the desired meridian of the cornea.

Cataract surgery was performed using the standard method with a temporal clear corneal incision of 2.75 mm and capsulorhexis of 5.0-5.5 mm.

For all patients, an Acrysof Toric lens type SN60T3, SN60T4, SN60T5, SN60T6, SN60T7, SN60T8, or SN60T9 was used as suggested by the online calculator. First, the IOL was placed within 10-15° of the desired meridian. Then, after the viscoelastic was completely removed from the anterior and posterior of the IOL, the lens was rotated clockwise using the I/A probe until it was in the desired position, i.e. the toric lens hash marks were completely aligned with the limbal marks showing the desired meridian of the cornea. After that, stromal hydration was done at the incision site. No eyes were sutured at the end of the surgery and no complications were noted during the surgery. After surgery, chloramphenicol drops for one week and betamethasone drops with tapering over three weeks were prescribed.

Postoperative examinations, which were carried out on days 1, 7 and then the 1<sup>st</sup>, 3<sup>rd</sup> and 6<sup>th</sup> months, included refraction, UCVA, BCVA, slit-lamp examinations, IOP

measurement, evaluation of the fundus, measurement of residual refractive astigmatism, postoperative corneal astigmatism, IOL rotation, and patients' spectacle independence for distance vision.

To evaluate spectacle independence, the patients were asked about the use of spectacle for distance vision (never, sometimes, always).

To evaluate IOL rotation, in the upright position, after dilating the pupil, a narrow slit beam of the slit-lamp was rotated to align the IOL hash marks. Then, using the degree scale on the top of the slit lamp (BQ-900, Haag-Streit), the axis of the IOL to the nearest 5-degree increment was determined.

## Results

During the study period, we enrolled 16 patients (20 eyes) with a mean age of 64±9.80 years; 10 were women. Table 2 shows preoperative data of the participants.

Six months after the surgery, All eyes (100%) had a UCVA of  $^{20}/_{32}$  or better and 80% had a UCVA of  $^{20}/_{25}$  or better.

All eyes had a BCVA of  $^{20}/_{32}$  or better and 95% had a BCVA of  $^{20}/_{25}$  or better. Postoperative refractive astigmatism was 0.75 D or less in 100% of the eyes and between 0 and 0.5 D in 90% of the eyes.

The difference between pre and postoperative mean keratometric cylinder was 0.25 to 0.5 D in all eyes; this indicated the negligibility of surgically induced astigmatism in the operated eyes (Table 3).

IOL rotation was 0° in 65% and 4° or less in 90% of the eyes. IOL rotation was 5° or more in 10% of the eyes (two eyes), 6° in one of the eyes and 8° in the other. Spectacle independence for distance vision was 85% in our study (the patients who never used spectacle for distance vision).

**Table 2.** Preoperative data of the participants

Parameters	
Range of best corrected visual acuity	$^{20}/_{200}$ to $^{20}/_{25}$
Mean sphere ± SD (D) (range)	- 2.01±3.92 (-10.00 to +5.25)
Range of corneal astigmatism (D)	1.00 D to 4.00 D

**Table 3.** Data of refractive astigmatism, keratometry and postoperative sphere

	Minimum	Maximum	Mean±SD
Preoperative Astigmatism (D)	1.00	4.50	2.97±0.90
Postoperative Astigmatism(D)	0	0.75	0.28±0.23
Difference between preoperative and postoperative astigmatism (D)	0.75	4.00	2.62±0.90
Difference between preoperative and postoperative keratometry	0.25	0.50	0.32±0.15
Postoperative sphere (D)	-0.75	+1.25	+0.13±0.52

## Discussion

Today, modern cataract surgery is intended to make individuals needless of glasses. On one hand, applying new formulas for precise IOL power calculation, and on the other hand, using safe methods to minimize astigmatism could help accomplish the above objective.

Acrysof Toric IOLs provide a viable option among methods such as limbal incision and excimer laser for correcting corneal astigmatism in patients who are candidates of cataract surgery. In 2008, Mendicute et al<sup>16</sup> performed cataract surgery and Acrysof Toric IOL (SN60T3, SN60T4, SN60T5) implantation in 30 eyes with corneal astigmatism more than 1.0 D and reported a UCVA of  $^{20}/_{25}$  or better in 100% of the eyes, postoperative residual astigmatism of 0.5 D or less in 94%, and a mean IOL rotation of  $3.6\pm 3.1^\circ$  at three months.

In 2009, Mesa et al<sup>17</sup> evaluated the results with the same range of Acrysof Toric IOLs (SN60T3, SN60T4, SN60T5) in 32 eyes that underwent refractive lens exchange. In their study, postoperative UCVA was  $^{20}/_{32}$  or better in 100% and  $^{20}/_{25}$  or better in 84.3% of the eyes. IOL rotation was  $5^\circ$  or less in 96.8% of the eyes six months after surgery.

In 2010, Ahmed et al<sup>18</sup> evaluated the efficacy of Acrysof Toric IOLs (SN60T<sub>3</sub>, SN60T<sub>4</sub> and SN60T<sub>5</sub>) in correcting corneal astigmatism of 1.0-2.5 D in 234 eyes. Mean postoperative residual astigmatism was  $0.4\pm 0.4$  D and IOL rotation was  $5^\circ$  or less in 91% and  $10^\circ$  or less in 99% of the eyes, six months after surgery, and 69% of patients achieved spectacle independence for distance vision.

The results of our study were coherent with the findings of previous studies on SN60T3,

SN60T4 and SN60T5 IOLs. Our findings showed that the results of using Acrysof Toric IOLs higher than SN60T5 (SN60T6, SN60T7, SN60T8, and SN60T9) in eyes with regular corneal astigmatism up to 4 D were acceptable regarding IOL rotation, residual refractive astigmatism, and vision outcomes, similar to SN60T3, SN60T4 and SN60T5 Acrysof toric lenses.

In our study, 20 eyes of 16 patients with cataract and corneal astigmatism of 1.0-4.0 D were selected, and depending on the amount of corneal astigmatism an Acrysof Toric IOL type SN60T3, SN60T4, SN60T5, SN60T6, SN60T7, SN60T8, or SN60T9 was implanted. This range of Acrysof Toric IOLs was wider than the range used in previous studies (SN60T3, SN60T4 and SN60T5). Between three methods of manual keratometry (Javal), corneal topography, and IOL Master, we opted to use the amount and axis of the corneal astigmatism measured by the manual keraometry (Javal).

All eyes received a temporal clear corneal incision of 2.75 mm. In all eyes, the difference between pre and postoperative mean keratometric cylinder was 0.25-0.5 D (surgically induced astigmatism was considered 0.25 D for all patients in the preoperative Toric IOL calculation form), which showed the negligibility of incision induced astigmatism in operated eyes. Therefore, postoperative residual astigmatism can be largely attributed to IOL misalignment.

For every 1 degree IOL misalignment from the desirable meridian, astigmatism correction is diminished by 3.3%; a  $10^\circ$  IOL misalignment takes away one third of the effect and a  $30^\circ$  misalignment totally annuls

the corrective effect of the IOL. Therefore, it could be said that the most important factors that affect the result of refraction and postoperative visual outcome is minimal surgically induced astigmatism and minimal IOL misalignment.

IOL misalignment can be caused by erroneous corneal marking before or during surgery, improper positioning and alignment of the IOL during surgery, and IOL rotation after surgery. Preoperative marking should be done with the patient in sitting position to avoid cyclotorsion of the eye, and the head should be held straight and without tilt. Also, marking with the Mendez marker and IOL positioning should be done with care. One of the major concerns with toric lenses is the probability of rotation after surgery. With the Acrysof Toric lenses, there is good bioadhesion between the posterior surface of the lens and the posterior capsule which prevents IOL from rotation.

Other factors that help to prevent IOL rotation include a well-centered capsulorhexis of an appropriate size (the edge of the anterior capsule should slightly overlap with the IOL haptic), proper irrigation of viscoelastic and its complete removal at the conclusion of surgery, and well forming of the anterior chamber.

The rhexis size was 5.0-5.5 mm in all our patients; the viscoelastic was completely removed from the eye at the end of the surgery and the anterior chamber was well formed. IOL rotation in our patients was 0 degrees in 65% and 4° or less in 90% of the cases six months after surgery. Lens misalignment was 6° in one operated eye and 8° in another one.

Residual refractive astigmatism was 0.75 D or less in 100% and between 0 D and 0.5 D in 90% of the eyes. Residual refractive astigmatism more than 0.5 D was seen in eyes with more than 4° IOL rotation.

UCVA was  $20/32$  or better in 100% and  $20/25$  or better in 80% of the eyes and spectacle independence for distance vision was 85%. Decreased UCVA was due to residual refractive astigmatism in some eyes and the sphere in the postoperative refraction of some eyes.

In our study, Acrysof Toric IOL implantation during cataract surgery for patients with regular corneal astigmatism was an effective, predictable and rather stable method for correcting astigmatism. Points to be considered include appropriate patient selection, regularity of the corneal astigmatism in topography, precise marking of the cornea, surgery with no or minimal astigmatism induction (astigmatism-neutral surgery), appropriate placement of the IOL in the desired position and correct assessment of the axis of IOL placement after surgery.

On the other hand, according to a population based study in Tehran (Tehran Eye Study) which addressed ophthalmologic indices, the prevalence of 1.0-4.0 D corneal astigmatism was estimated to be 35.5% in the over 40 year old population of Tehran using the Orbscan.<sup>19</sup> Also, in another population based study (Shahroud Eye Cohort Study) which is being conducted in one of the cities of Iran, the prevalence of 1.0-4.0 D corneal astigmatism in the over 40-year-old population has been determined to be 31.4%. These two studies, covering two large areas of Iran, have shown a relatively high prevalence of 1.0-4.0 D corneal astigmatism in the over 40-year-old population of these areas.

## Conclusion

Considering the acceptable results with Acrysof Toric IOLs (SN60T3 to SN60T9) in correcting corneal astigmatism of 1.0-4.0 D, they can be suggested as a safe and stable method to correct astigmatism in patients who undergo cataract surgery.

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