

Use of Toric Intraocular Lens in Correcting Regular Astigmatism during Cataract Surgery

Mahmoud M. Ismail, Ahmad E.Hudeib, Mohamed F. Khattab*

Department of Ophthalmology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

*Corresponding author: Mohamad F. Khattab E-mail: dr.mfawzy88@gmail.com Telephone No.: +2001002952128

Abstract

Background: to date Toric intraocular lenses (IOLs) have reported to be an effective method to reduce pre-existing refractive corneal astigmatism and so spectacle independence following cataract surgery.

Aim of the Work: was to evaluate the visual and refractive outcomes and the rotational stability of the Envista Toric Intraocular Lens after cataract surgery in patients with pre-existing corneal astigmatism.

Patients and Methods: this study included 20 Eyes of 20 patients submitted to cataract surgery with pre-existing corneal astigmatism of 1.50 D. or more at Al-Hussein University Hospital and Nour Al-Hayah Eye Hospital between July 2017 and August 2018 that were implanted with Envista Toric Intraocular Lens after phacoemulsification surgery

Results: Using toric IOL to correct corneal astigmatism is a relatively new surgical choice in patients with a cataract and previous corneal astigmatism. After three months post operative, UCVA (Decimal), BCVA (Decimal) and Rotation (degrees) were: 0.5₋₁ (0.81±0.14), 0.9₋₁ (0.97±0.05) and 0₋₇ (2.75±1.65) respectively

Conclusion: It could be concluded that Toric IOL implantation was a successful surgical for correction of astigmatism and cataract without affecting corneal integrity.

Keywords: Toric intraocular lenses, Cataract, Astigmatism

INTRODUCTION

Astigmatism is considered one of the most common refractive error which increases with age

⁽¹⁾ Both astigmatism and cataract are impairing vision and life, so in single operation by implantation of toric IOL we can improve quality of life and get rid of spectacles⁽²⁾.

Specific toric intraocular lenses were designed firstly by Shimizu in 1992, These types of lenses have been used to correct Astigmatism during phacoemulsification surgery⁽³⁾.

Today, cataract surgery is considered to be refractive surgery that gives us dual benefit by one operation, getting rid of spectacles and remove cataract as well⁽⁴⁾.

AIM OF THE WORK

The aim of this study was to evaluate the visual and refractive outcomes and the rotational stability of the Toric IOL after cataract surgery in patients with regular corneal astigmatism

PATIENTS AND METHODS

This prospective non-comparative clinical study included a total of 20 Eyes of 20 patients submitted to cataract surgery and were implanted with Envista Toric Intraocular Lens after phacoemulsification surgery. Patients attended at Al-Hussein University Hospital and Nour Al-Hayah Eye Hospital. Approval of the ethical committee and a written informed consent from all the subjects were obtained. This study was conducted between July 2017 and August 2018.

Preoperatively, all patients underwent certain examinations that included medical history and specific ophthalmic examination that included uncorrected distance visual acuity (UCVA) and Best corrected distance visual acuity (BCVA) using, slit lamp evaluation, and cycloplegic refraction, intraocular pressure and fundus examination. An Optical biometry (IOL Master, Carl Zeiss Meditec AG) was used to measure axial length, keratometry, and anterior chamber depth. Inclusion criteria of this study enrolled the eyes that had visually significant cataract, age over 40 years and preexisting regular corneal astigmatism of (-1.50 D to -6).

Inclusion Criteria: patients over 50 years with clinical features of age-related maculopathy, such as soft or hard drusen, pigmentary alterations and macular exudative signs on FFA.

Exclusion Criteria: Patients with irregular astigmatism, corneal disease or opacities, previous corneal or intraocular surgery, macular degeneration or retinopathy, glaucoma and optic nerve diseases.

Surgical technique

Preoperatively, manual marking was done on limbus at 0 and 180 degrees when the patient is sitting at a slit lamp with a sterile marker. All surgeries were done by the same surgeon using local anesthesia. Phacoemulsification was performed through a superior corneal incision. The target diameter of capsulorhexis was 5.5 mm to allow overlap of the anterior lens margin on IOL border. An ophthalmic viscosurgical device (OVD) was used in all patients. After implantation of toric IOL, this IOL was rotated to align the cylinder with the suitable axis. After removal of the OVD, sealing of the incisions was done by hydration. All patients were administered a subconjunctival Gentamycin and dexamethasone at the end of surgery.

Post-operative Assessment

Postoperative examinations were performed at 1 day, 1 month and 3 months. UCVA, BCVA, refraction and keratometry were recorded in all patients. IOL alignment was determined under mydriasis by slit lamp examination.

Postoperative treatment consisted of topical Antibiotic and dexamethasone 6 times a day tapered over 1.5 month.

Statistical analysis

Collected data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean standard deviation (SD). Qualitative data were expressed as frequency and percentage.

Results

This study was conducted on 20 eyes of 20 subjects who underwent phacoemulsification and posterior chamber foldable Toric IOL implantation. The mean age was 53.85 with range 47-63. table (1)

Table (1): Age (years) distribution of the study group.

Age (years)	Total (N=20)
≤50 years	5 (25%)
>50-55 years	8 (40%)

>55-60 years	5 (25%)
>60 years	2 (10%)
Range [Mean±SD]	47_63 (53.85±4.72)

Patients were 12 females and 8 males as shown in table (2).

Table (2): Sex distribution of the study group.

Sex	Total (N=20)
Female	12 (60%)
Male	8 (40%)

A Previous sphere, spherical equivalent and IOP descriptive of the study group in table (3).

Table (3): A Previous sphere, spherical equivalent and IOP descriptive of the study group.

	Total (N=20)
Previous Sphere	-6.5_-0.25 (-2.08±1.44)
Spherical Equivalent	-7.25_2.25 (-2.65±1.86)
IOP	12_20 (16.30±2.56)

Clinical Results

The difference in Astigmatism pre and post operative this study was significant as shown in a table (4)

Table (4): The extent of the difference in astigmatism over the periods in the study group.

Astigmatism	Range [Mean±SD]	Mean Diff.
Pre	-3.75_-1.5 (-2.50±0.66)	
After 1 day	-1.25_0 (-0.55±0.39)	-1.95±0.43
After 1 month	-1_0 (-0.45±0.32)	-2.05±0.60
After 3 months	-1.25_0 (-0.40±0.32)	-2.10±0.56

This study shows highly statistically significant difference over the periods through UCVA decimal in a table (5).

Table (5): The extent of the difference over the periods through UCVA decimal in the study group.

UCVA Decimal	Range [Mean±SD]	Mean Diff.
Pre	.05_0.4 (0.19±0.13)	
After 1 day	0.3_0.8 (0.50±0.15)	-0.31±0.18
After 1 month	0.5_1 (0.79±0.16)	-0.60±0.20
After 3 months	0.5_1 (0.81±0.14)	-0.62±0.19

This study shows highly statistically significant difference over the periods through BCVA decimal in a table (6).

Table (6): The extent of the difference over the Periods through BCVA decimal in the study group.

BCVA Decimal	Range [Mean±SD]	Mean Diff.
Pre	0.2_0.8 (0.45±0.16)	
After 1 day	0.5_0.8 (0.65±0.11)	-0.20±0.22
After 1 month	0.8_1 (0.97±0.06)	-0.52±0.20
After 3 months	0.9_1 (0.97±0.05)	-0.52±0.19

Rotationally stable toric IOL was a significant landmark of success of this study that were as in table (7)

(SD = 0.11), and on 30th pos-op day was 0.081 (SD = 0.11).

Table (7): The extent of the difference over the periods through degree of rotation in the study group.

Degree of Rotation	Range [Mean±SD]
After 1 day	0_6 (2.30±1.56)
After 1 month	0_6 (2.65±2.03)
After 3 months	0_7 (2.75±1.65)

DISCUSSION

It is very important to calculate both astigmatism and spherical refractive errors to get the best post-operative visual outcome. Spectacle removal in cataract patients with astigmatism can be done with Toric Intraocular Lens⁽⁵⁾.

The effectivity of the correction can be achieved by accurate aligning of a toric IOL which is the most important factor determining the success of the operation⁽⁶⁾.

Axis alignment is a major factor to have good visual outcomes of toric IOL implantation, misalignment of toric IOLs remains a barrier to the optimize good postoperative results⁽⁷⁾.

In this study, we implanted foldable Envista toric AcrySof IOL in 20 eyes of 20 patients with pre-existing corneal astigmatism of 1.50 D. or more.

Although present study included a small group (only 20 eyes), it is assumed that data reliability is high because of the homogeneous nature of the patients (similarities of age, cataract type and severity, phaco time and so on)

The visual improvement after toric IOL implantation in the current study was comparable to other studies. Uncorrected Distance visual acuity (UCVA) was checked on 1st day, 1st month and 3 months post-operative.

In our study, the mean decimal UCVA was 0.19 (SD=0.13) pre operative, 0.50 (SD = 0.15) at 1st day post-operative, 0.79 (SD = 0.16) one month post-operative and 0.81 (SD = 0.14) after three months

In a study by *Javed et al.*⁽⁸⁾, prospective study included 64 eyes of 40 patients with more than 1.50 dioptre (D) of pre-existing corneal astigmatism undergoing phacoemulsification with implantation of the AcrySof® toric IOL. evaluated that Uncorrected visual acuity (UCVA) after toric IOL implantation was checked on 1st, 7th and 30th postoperative day.

The mean log MAR UCVA at 1st post-op day was 0.172 (SD = 0.02), on 7th post-op day was 0.138

Kjell, Prospective non-comparative study included 30 eyes of 30 patients, evaluated that mean binocular uncorrected distance, intermediate, and near visual acuities (log MAR) were -0.05±0.11, -0.03±0.08, and 0.09±0.10, respectively. Using Tecnis Symfonytoric ERV IOLs

In a study by *Seth et al.*⁽⁹⁾, prospective controlled trial evaluated IOLs, implantation of 21 patients The mean log MAR UCVA At 3 months postoperatively, was (0.20 ± 0.13).

Francisco et al.⁽¹⁰⁾, retrospective, non-randomized study, included 97 eyes of 61 patients, evaluated that mean uncorrected distance visual acuities (log MAR) was (0.12 ± 0.12) using Precizontoric IOL.

In our study, the mean decimal BDVA was 0.45 (SD=0.16) pre operative, 0.65 (SD = 0.11) at 1st day post-operative, 0.97 (SD = 0.06) one month post-operative and 0.97 (SD = 0.05) after three months

In a study by *Javed et al.* evaluated AcrySof toric IOL implantation in 64 eyes of 40 patients The mean log MAR BCVA at one month was -0.02 (SD = 0.08) and at three months was -0.04 (SD = 0.76)

In a study by *Francisco et al.* BCVA (LogMar) was (0.026 ± 0.06) and none of the eyes lost any line of BCVA postoperatively.

In a study by *Song et al.*⁽¹¹⁾, Multicentre, randomized, open and positive parallel controlled clinical study. A total of 121 patients (121 eyes) who had cataract combined with corneal regular astigmatism and met the inclusion criteria were enrolled in 9 hospitals from May 2014 to May 2016., mean BCVA of the study was 20/40 or more in 100% of the study population.

In our study, the mean refractive cylinder pre-operative was -2.50(SD=0.66) D., 0.55 (SD = 0.39) D at 1st day post-operative, 0.45 (SD = 0.32) D one month post-operative and 0.40 (SD = 0.32) D after three months.

Carolina et al.⁽¹²⁾ evaluated that mean refractive cylinder pre-operative was 2.34 (SD = 0.95) D., one week post-operative was 0.43(SD=0.38) D, after one month was 0.36 (SD = 0.36) D, 0.27(SD=0.28)D three months postoperative and 0.24 (SD=0.27) D six months post-operative.

Atsushi et al.⁽¹³⁾ That included 18 eyes of 16 patients who underwent cataract surgery

with the insertion of a toric implant, showed that The mean postoperative remaining refractive astigmatism of 0.73 ± 0.55 diopters (D)

Javed *et al.* showed that the mean residual refractive astigmatism was 0.57 D (SD = 0.29 D) at the final follow-up, which was at 3 months. This was similar to the study done by Kern *et al.*(14), prospective clinical trial with 64 eyes of 45 patients had implantation of a toric intraocular lens (Zeiss Torbi 709 M), the astigmatic prediction error was between -0.52 D and -1.00 D

Rotational stability is very important to reach better visual consequences of Toric IOLs.

There are different factors that determine rotation of IOL especially in early periods postoperative before healing process of capsular bag such as: IOP fluctuation, OVD clearance, IOL design and capsulorrhexis size and centration

In our study, The Degree of Rotation is 2.3° (SD=1.56) 1st day post-operative, 2.65° (SD=2.03) after one month and 2.75° (SD=1.65) after three months.

In this group, after 3 months, 95 % of IOL axis was within $\pm 5^\circ$ of the operation axis and all were within $\pm 7^\circ$

Mayer *et al.*(15), that comprised 57 eyes of 29 patients; there were 28 eyes in the manual group and 29 eyes in the digital group. The mean toric IOL misalignment was significantly lower in the digital group than in the manual group (2.0 degrees ± 1.86 [SD versus 3.4 ± 2.37 degrees; $P = .026$).

Also Weber *et al.*(16), randomized clinical trial enrolled 36 eyes (24 patients). The mean toric IOL misalignment was (2.8 ± 1.8 degrees; $P = .02$) and 3 months (3.1 ± 2.1 degrees; $P < .05$) postoperatively.

The very low mean rotation at 6 months from the required axis in Carolina *et al.* study of $2.43^\circ \pm 1.55^\circ$, with IOL rotation $\leq 4^\circ$ in 90% of the eyes and with no IOL rotation more than 6° .

IOL rotation can also be affected by design of haptic and model of IOL.

Rotational stability is critical for toric IOL efficiency. One degree of axis rotation can result in a loss of 3.3% of astigmatic power of lens, and with 30 degree rotation of IOL, there is complete loss of cylinder power. Titiyal *et al.*(17).

Rotation is less frequent after fusion of anterior and posterior capsules. The main cause main of rotation is haptic compression resulting from capsule contraction. This occurs mainly in the

first 3 months postoperative. Accurate rotational stability was effective in reducing preexisting corneal astigmatism, based on deviation of the mean axis and degrees of IOLs rotation. *David et al.*⁽¹⁸⁾.

Shimizu et al.⁽¹⁹⁾ found that C-loop haptic IOLs had the highest rate of rotation post-operative. (41% >10 degrees), but Plate haptic-toric IOLs have better rotational stability (2% to 50% >10 degrees).

No eye had secondary surgery for IOL repositioning. Our results are similar to those reported by *Seth et al.* (2018), this prospective randomized controlled trial included Forty-two eyes of 42 cataract patients with preexisting astigmatism of 1 D or more were randomized to receive plate haptic toric (AT TORBI) or loop haptic toric (AcrySof) IOLs, with 21 in each group, The mean IOL rotation at 3 months

Follow-up in plate haptic group was found to be $3.52 \pm 3.84^\circ$ and in loop haptic group was $2.05 \pm 2.56^\circ$ ($P = 0.25$).

Our results show that Toric IOL is an effective surgical option to correct corneal astigmatism and spectacle dependence after cataract surgery.

Limitations of this study:

- 1- Small sample size.
- 2- Three months postoperative follow up only.

CONCLUSION

There are now several types of toric IOL, multifocal, phakic and standard toric IOLs. Both corneal topography and keratometry are important to be addressed before surgery. Implantation along the proper axis and rotational stability are the critical success factors of this procedure.

Toric IOL implantation allows correction of astigmatism without affecting the integrity of the cornea. Good results and reduction of healing time of the cornea can be predicted by Toric IOL implantation.

It is difficult to compare rotational lens stability between studies due to methodologies variation.

Toric IOLs are a successful and hopeful alternative method to correct corneal astigmatism.

REFERENCES

- 1- **Dick HB, Schultz T, Klin M *et al.* (2017):** New Developments in Cataract Surgery. doi: 10.1055/s-0042-121423.
- 2- **Chen H, Wang J (2016):** Toric intraocular lens implantation in children with developmental

cataract and preexisting corneal astigmatism.doi: 10.1111/aos.13312.

3- Ninomiya Y, Minami K, Miyata K *et al.* (2016): Toric intraocular lenses in eyes with with-the-rule, against-the-rule, and oblique astigmatism: One-year results. *Cataract Refract Surg.*,42:1431-1440.

4- Kjell(2018): Gunnar Gundersen. Rotational stability and visual performance 3 months after bilateral implantation of a new toric extended range of vision intraocular lens, 12: 1269–1278

5- Laura R, Juan A, Monsoriu *et al.* (2017): Influence of different types of astigmatism on visual acuity, 10(3): 141–148.

6- Moulick PS, Mohindra VK, Gurunadh VS *et al.* (2018): A clinical study to evaluate the results after toric intraocular lens implantation in cases of corneal astigmatism, *74(2):133-138.*

7- Raucau M, ElChehab H, Agard E *et al.* (2018): Toric lens implantation in cataract surgery: Automated versus manual horizontal axis marking, analysis of 50 cases, 4:e1-e9.

8- Javed HF, Archana K, Ranjan D *et al.* (2015): Management of moderate and severe corneal astigmatism with AcrySof® toric intraocular lens implantation,DOI:10.1016.07.002

9- Seth SA, Bansal RK, Ichhpujani P *et al.* (2018): Comparative evaluation of two toric intraocular lenses for correcting astigmatism in patients undergoing phacoemulsification,66:1423-1428

10- Francisco B, Merce M, Daniel E *et al.* (2018): Transitional conic toric intraocular lens for the management of corneal astigmatism in cataract surgery,12: 1071–1079.

11- Song XD, Hao YS, Bao YZ *et al.* (2018):A multicenter study of the effectiveness and safety of Toric intraocular lens implantation, 54(5):349-356

12- Carolina V, Carlos M, Firmino *et al.* (2016): Astigmatism management in cataract surgery with Precizontoric intraocular lens,10: 151–159

13- Atsushi K, Yoshinori T (2016): Vector analysis investigation of toric intraocular lens with no deviation from the intended axis,10: 2199–2203.

14- Kern, Kortüm M, Müller *et al.* (2018): Comparison of Two Toric IOL Calculation Methods ,28:40-46

15- Mayer WJ, Kreutzer T, Dirisamer M *et al.* (2017): Comparison of visual outcomes, alignment accuracy, and surgical time between 2 methods of corneal marking for toric intraocular lens implantation ,10:1281-1286.

16- Webers V, Bauer N, Visser N *et al.* (2017): Image-guided system versus manual marking for toric intraocular lens alignment in cataract surgery,6:781-788.

17- Titiyal JS, Kaur M, Jose CP *et al.* (2018): Comparative evaluation of toric intraocular lens alignment and visual quality with image-guided surgery and conventional three-step manual marking ,12:747-753.

18- David S, Curragh, Patrick H *et al.* (2017): Prevalence of Corneal Astigmatism in an NHS Cataract Surgery Practice in Northern Ireland,86(1): 25–27.

19- Shimizu K, Misawa A, Suzuki Y *et al.* (1994): Toric intraocular lenses: correcting astigmatism while controlling axis shift. *J Cataract Refract Surg.*, 20:523-6.