Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-8, Issue-4 | July-August 2022
DOI: 10.53339/aimdr.2022.8.4.24
Page no- 216-224 | Section- Research Article (Ophthalmology)

An Effective Method for Toric Intraocular Lens Implantation Based on Refractive Power Analyzer system and Slit lamp.

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Received: 28 April 2022
Revised: 05 June 2022
Accepted: 14 June 2022
Published: 23 June 2022

Abstract

Background: One of the most widely performed surgical procedures nowadays is cataract surgery combined with monofocal intraocular lens implantation (IOL). Monofocal IOLs can compensate for the spherical refractive error but not astigmatism. Thus, patients with astigmatism are unable to see well after surgery without spectacles. A new generation of IOLs called toric IOLs, improve uncorrected visual acuity in eyes with high astigmatism due to a specific lens design. This study aimed to present a practical method of toric intraocular lens (IOL) implantation based on a refractive power analyzer system and slit-lamp observation. **Material & Methods:** This prospective study comprised 30 patients who underwent toric IOL implantation with cataract extraction at the Department of Ophthalmology, National Institute of Ophthalmology, Dhaka, Bangladesh. This study was conducted from Jan 2021 to Dec 2021. Approval from the local ethical committee was obtained. **Results:** The study included 45 eyes of 30 patients. The sex distribution of the study patients where the male was 18(60%) and the female was 12(40%). In the age distribution of the study, 5(16.67%) patients were from the 60-69 range, 10(33.33%) patients were from the 70-79 range, and 15(50.00%) patients were from the 80-89 range. The patients' demographic variables consequently. Changes in visual acuity and refraction are shown in table-4 thorough preoperative and postoperative. Postoperative IOL alignment methods are shown in table-5, the mean±SD of the slit-lamp target was 2.55±2.76 and in the range, of 0.0 to 12.0, the mean±SD of the corneal analyzer target was 2.55±1.98 and range was 0.0 to 11.0, and the mean±SD of the slit-lamp corneal analyzer was 3.27±2.98 and range was 0.0 to 16.0. **Conclusions:** We studied 2 methods of assessing toric IOL alignment postoperatively and found no significant difference between them. Both were reliable and predictable. In addition, we found that the simple preoperative marking technique we used yielded toric IOL alignment that was as accurate as that obtained with other commonly used techniques and that was within a clinically acceptable level.

Keywords:- Toric Intraocular Lens, Implantation, Refractive Power, Analyzer system, Slitlamp.

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INTRODUCTION

A recent advance in cataract surgery was the introduction of toric intraocular lenses (IOLs) for the correction of astigmatism.[1] Astigmatism, a common refractive error found in 15% to 29% of prospective cataract patients,[2,3,4] is caused by the corneal shape, crystalline lens shape, or a combination. Implantation of a toric IOL at the time of cataract removal is a predictable, single-step procedure to minimize residual refractive error.[5] The toric IOL has different optical powers in different meridians; therefore, the IOL must be correctly aligned to neutralize astigmatism in the cornea. Each degree of error in alignment of the toric IOL reduces the cylinder power effect by approximately 3.3%.[6,7] A toric IOL placed 30 degrees off-axis would provide no correction for astigmatism and would induce further refractive error. It is well established that positionally induced cyclotorsion is an important factor when correcting astigmatism in cataract and refractive surgery.[8,9,10,11,12] A variety of techniques, devices, and methods are used to guide the surgeon when aligning the toric IOL. Numerous studies of the performance of excimer laser astigmatic surgery, toric IOLs, or phakic IOLs describe different methods for marking the eye preoperatively.[13,14,15,16,17,18,19] Most surgeons mark reference points on the cornea or limbus before surgery to act as a guide when implanting the IOL and to counteract cyclotorsion that can occur when the patient is supine. A misaligned toric IOL has to be identified early to allow timely realignment. Several studies,[5,14,18,19] show that once implanted, these IOLs are rotationally stable. Postoperative assessment of IOL alignment can be achieved by many methods. The most common clinical methods are assessment via a slit-lamp eyepiece reticule or alignment of the slit-lamp beam with the IOL markings. Another simple objective measure of alignment is to use the Internal OPD Map on the ARK-1000 OPD-Scan refractive power/corneal analyzer system (Nidek). The system gives information on corneal topography, wavefront, auto-refraction, keratometry, and pupillometry in a single unit. Recent reports highlight the value of this instrument in the preoperative and postoperative assessment of toric IOL patients.[20,21] This study aimed to present a practical method of toric intraocular lens (IOL) implantation based on a refractive power analyzer system and slit-lamp observation.

MATERIAL AND METHODS

This prospective study comprised 30 patients who underwent toric IOL implantation with cataract extraction at the Department of Ophthalmology, National Institute of Ophthalmology, Dhaka, Bangladesh. This study was conducted from Jan 2021 to Dec 2021. Approval from the local ethical committee was obtained. Informed consent was obtained from each patient and the tenets of the Declaration of Helsinki were followed.

Inclusion criteria

- Patients were cataracts and regular corneal astigmatism of 1.25 D or more.

Exclusion criteria

- Patients were as follows: irregular corneal astigmatism, corneal disease, previous intraocular or corneal surgery, glaucoma,

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pseudoexfoliation, uveitis, zonule or pupil abnormalities, macular degeneration or retinopathy, and retinal detachment.

Preoperatively, each patient had a full ophthalmic examination including uncorrected (UCVA) and corrected (BCVA) visual acuities, objective auto-refractor keratometry (Canon RK-F1, Japan), subjective refraction, intraocular pressure measurement, slit-lamp examination, fundoscopy with dilated pupil, and corneal topography (Sirius, Scandicci, FI, Italy). Biometry was carried out with optical coherence biometry (Lenstar, Haag-Streit Company, Switzerland) using the SRK-T formula. Toric IOL that we used in this study was Alcon Acrysof toric IOL. The power and axis of toric IOL were determined using the manufacturer's online calculator (www.acrysoftoriccalculator.com). Just before surgery, the corneal meridian that the IOL axis to be intended to place (the steepest meridian usually) was marked at the corneal limbus with a sterile ink pen, with the patient sitting upright at the slit-lamp. The same experienced surgeon (HB) performed all surgeries via standard phacoemulsification using topical plus intracameral anesthesia with a 2.8-mm keratome incision at the intended axis according to the calculation. The toric IOL was injected into the capsular bag with a Monarch-II injector (Alcon Laboratories, USA) and rotated to a final position by exactly aligning its reference markers with the limbal implantation marks. Statistical analysis was performed using SPSS for Windows (version16.0, SPSS Inc). Wilcoxon signed-rank test was used to compare pre-and postoperative data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study included 45 eyes of 30 patients. [Table 1] shows the sex distribution of study patients where the male was 18(60%) and female was 12(40%). [Table 2] shows the age distribution of the study, 5(16.67%) patients were from the 60-69 range, 10(33.33%) patients were from the 70-79 range, and 15(50.00%) patients were from the 80-89 range. [Table 3] shows the patients' demographic variables consequently. Changes in visual acuity and refraction are shown in [Table 4] thorough preoperative and postoperative. Postoperative IOL alignment methods are shown in table-5, the mean±SD of the slit-lamp target was 2.55±2.76 and the range from 0.0 to 12.0, and the mean±SD of the corneal analyzer target was 2.55±1.98 and range was 0.0 to 11.0, and the mean±SD of the slit-lamp corneal analyzer was 3.27±2.98 and range was 0.0 to 16.0. [Figure 1] shows the efficiency of postoperative UDVA (Blue color) versus preoperative CDVA (Orange Color). The predictability of postoperative defocus equivalent refraction is shown in [Figure 2].

Table 1: Sex distribution of study patients (N=30)

Sex Distribution	Frequency	Percentage
Male	18	60
Female	12	40

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Table 2: Age range of study patients (N=)

Age range	Frequency	Percentage
60-69	5	16.67
70-79	10	33.33
80-89	15	50.00

Table 3: Demographic variables of study patients (N=)

Variable	Value
Preop refractive sphere (D)	
Mean±SD	1.55±3.64
Range	-8.50 to +7.50
Preop refractive cylinder (D)	
Mean±SD	-2.28±0.89
Range	-0.75 to -4.50
Mean keratometry (D)±SD	
K1	42.91±1.70
K2	45.63±1.80
Corneal cylinder (topographer)	
Mean±SD	2.7±0.9
Range	1.47 to 5.49
Defocus equivalent (D)	
Mean±SD	4.30±2.34
Range	1.00 to 9.88

Table 4: Changes in visual acuity and refraction.

Variable	Preoperative	Postoperative
UDVA (logMAR)		
Mean±SD	1.14±0.59	0.17±0.18
Range	0.18 to 2.00	-0.20 to 0.76
CDVA (logMAR)		
Mean±SD	0.29±0.13	-0.01±0.12
Range	0.10 to 0.60	-0.20 to 0.20
Defocus equivalent (D)		
Mean±SD	4.3±2.34	0.76±0.57
Range	1.00 to 9.88	0.00 to 2.50
Refractive sphere (D)		
Mean±SD	1.55±3.64	0.19±0.50
Range	-8.50 to 7.50	-1.50 to 1.50
Refractive cylinder (D)		
Mean±SD	2.29±0.89	-0.81±0.59
Range	-4.50 to 0.75	-3.25 to 0.00

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Corneal cylinder (D)		
Mean±SD	2.70±0.90	2.20±0.90
Range	1.47 to 5.49	0.85 to 4.86

Table 5: Postoperative IOL alignment.

Method	**IOL Orientation (Degrees)**	
	Mean±SD	**Range**
Slit-lamp target	2.55±2.76	0.0 to 12.0
Corneal analyzer target	2.65±1.98	0.0 to 11.0
Slit-lamp corneal analyzer	3.27±2.98	0.0 to 16.0

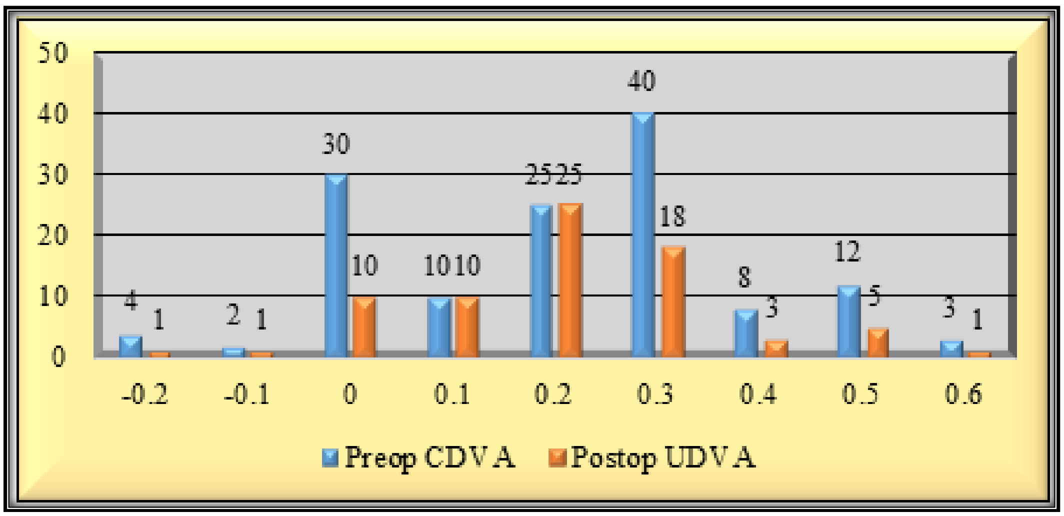

Figure 1: Efficiency: postoperative UDVA versus preoperative CDVA

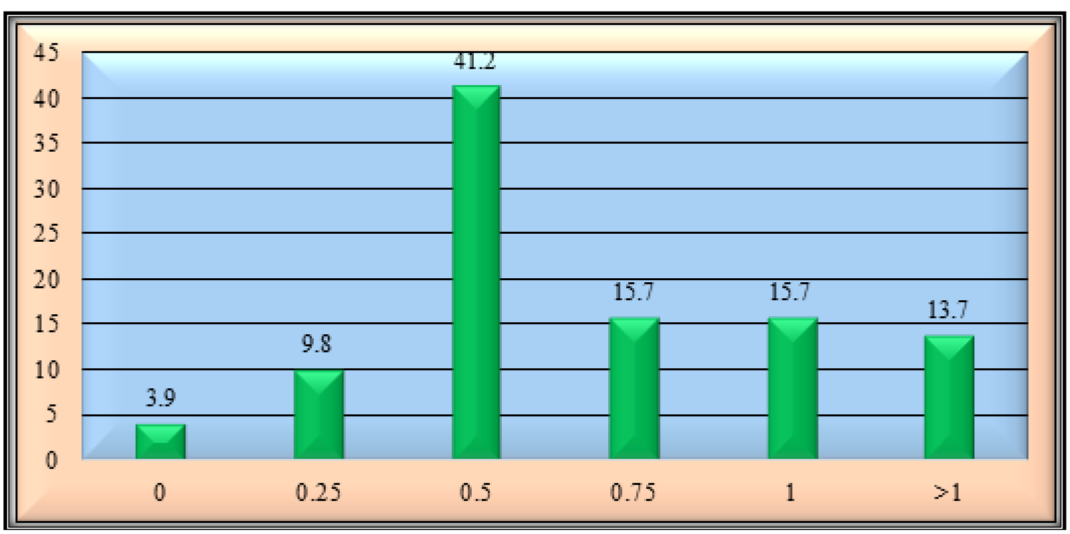

Figure 2: Predictability: postoperative defocus equivalent refraction.

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DISCUSSION

In toric IOL implantation, marking the astigmatic axis conventionally has two steps: The horizontal meridian is marked at the first step with the patient sitting upright at the slit-lamp to avoid cyclotorsion. Secondly, the steepest astigmatic axis is marked when the patient lies at the operating table. These two steps necessitate the surgeon to deal with two separate tasks. Also, the second step necessitates a special instrument showing meridional axes such as the Mendez ring. Using these types of rings may cause pain in some patients despite topical anesthesia and so they may be duly warned of the same. In recent years, new and sophisticated axis-marking methods such as iris fingerprinting or mapping have been developed.[22,23,24] All these methods have their pros and cons. Despite precision and accuracy, these methods necessitate expensive equipment or are time-consuming. Popp et al. compared four methods of corneal marking for astigmatism correction when the surgeon intended to correct astigmatism surgically with cataract surgery: pendular marker, bubble marker, tonometer marker, and scratching the cornea with an insulin needle at the slit-lamp.[25] They found that the slit-lamp marking technique showed the least vertical deviation and the pendular marker showed the least rotational misalignment. They concluded that most of the marking methods gave accurate results except the tonometer marker.[25] A simple objective technique to measure IOL alignment is using the internal optical path difference map on the ARK-1000 OPD-Scan refractive power/corneal analyzer system.[26] The point-spread function and wave-front data produced by the system are useful in analyzing the postoperative performance of toric IOLs; however, to our knowledge, this is the first report of the use of the internal map to determine toric IOL alignment. A dilated pupil is required for both methods of IOL axis estimation. The corneal analyzer scan requires a 6.0 mm pupil for accurate wave-front measurement. In our study, there was no statistically significant difference in measurement of IOL position between the slit-lamp method and the method using the internal map of the corneal analyzer. The difference between the 2 methods was 6 degrees or more in a small percentage of cases (6 eyes, 11.76%). Given the importance of early detection and realignment of a misaligned IOL, it may be worth using both techniques to check alignment in the early postoperative period. This is feasible because both methods require dilated pupils Our results confirm the importance of considering SIA when planning toric IOL surgery. In this study, there was a mean 0.50 D reduction in the corneal cylinder postoperatively. This is the usual SIA for the surgeon in the study (unpublished data), which indicates that most of the reduction in astigmatism in the study is a result of the toric IOL. The surgeon's known SIA was used in the IOL manufacturers' online calculator, which applies vector analysis to factor the amount and location of the SIA into the production of a target lens axis. We found that using the technique of placing 4 independently made, slit-lamp-aligned limbal marks resulted in the IOL being aligned to within a mean of 2.55 ± 2.76 degrees or 2.65 ± 1.98 degrees of the target axis, depending on the method of assessment. This compares favourably with other studies

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that used the same IOL but different preoperative marking techniques.[5,14,18] The 4-point marking technique we used resulted in toric IOL alignment that was approximately 1 degree more accurate than previously described methods. According to Novis and Ma and Tseng, this would translate to a 3.49% improvement in cylindrical performance over the other methods.[6,7] The 4-point preoperative marking technique we evaluated uses readily available equipment and requires no specific training. The suggested technique allows realignment of the slit beam and regeneration before each mark is made. Because each point is independently made, any error made when placing a mark is not automatically transferred to the other marks. The technique results in 4 independently created reference points with a common centre to guide the surgeon when placing the Mendez marker on the eye to mark the desired steep axis. The use of 4 reference points may provide greater accuracy than techniques using fewer marks; however, further analysis with more eyes is required to determine whether the differences are statistically significant. A weakness of this study was the lack of a control group. We described the accuracy of only 1 preoperative marking technique by comparing the results achieved with a target axis. It would be useful to compare the technique with another preoperative marking technique using the same IOL design, surgeon, and technicians. Further research on the process of preoperative marking of the eye is required. The most commonly used methods have evolved from those used in other astigmatic refractive surgeries. Insufficient research and data are available in this area to allow surgeons to confidently estimate the likely amount of misalignment associated with the technique they are using. Also, there is insufficient evidence that any particular preoperative marking technique is the most reliable.

Limitations of the study:

The study was conducted in a single hospital with small sample size. So, the results may not represent the whole community.

CONCLUSIONS

Personalized medicine is finding its place in most medical subspecialties, ophthalmology alike. Patients with the refractive error called astigmatism have an individual amount and axis of their astigmatism that has to be precisely determined before cataract surgery. Recently, such patients could not see well both at distance and near after cataract removal without spectacle wear because conventional monofocal IOLs could not correct patients' astigmatism. With the invention of technologically advanced intraocular lenses (IOL), every refractive error, including astigmatism and presbyopia, became treatable during cataract surgery. Monofocal toric IOL, which has to be produced individually, according to the specific measurements of each astigmatic eye, will enable patients to see well at distance even without spectacles. If a patient with astigmatism wants to be fully independent of spectacles after surgery, also presbyopia has to be corrected, and in such cases toric multifocal IOLs can be implanted for full visual recovery. In fact, with the invention of such "premium lenses," even patients aged 45 plus without cataracts are submitted to surgery on the lens as a refractive procedure. With the implantation of

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multifocal/trifocal (or toric version) IOL, they can regain their full vision at all distances without any spectacle use.

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Source of Support: Nil, Conflict of Interest: None declared