ORIGINAL ARTICLE

Residual astigmatism following cataract surgery

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ABSTRACT

Objective: To determine the amount of residual astigmatism following cataract surgery.

Materials and methods: A hospital based observational study was conducted in a tertiary eye hospital, Bangladesh during the period of July, 2013 to June, 2014. Patients was selected for the study who diagnosed as ARC with variable amount of astigmatism (1.5 to 3.5D), and excluded any other ocular pathology or history of previous ocular surgery. Phacoemulsification with PC Toric IOL implantation in all cases. Auto refracto-keratometer was done Preoperative and postoperatively for assessing the astigmatism. Main outcome measured were included preoperative uncorrected visual acuity, postoperative uncorrected visual acuity on 1stPOD, after 1 week and 1month, Preoperative keratometry, Preoperative astigmatism, Postoperative uncorrected keratometry on 1stPOD, after 1 week and 1month, Postoperative uncorrected astigmatism on 1stPOD, after 1 week and 1month

Results: 30 eyes of 28 patients were assessed in this study. Due to clear corneal incision during phacoemulsification, the steep meridian became flat significantly from pre-operative keratometry 44.329±1.473D (mean±SD) to 30thpost operative keratometry 43.971±1.431D (mean±SD) having $p<0.001$. On the other-hand the flat meridian became steeper from pre-operative keratometry 42.225±1.471D (mean±SD) to 30thpost operative keratometry 42.421±1.501D (mean±SD) having $p<0.001$. Preoperative mean astigmatism [Mean±SD] was 2.104±0.319D, after the first postoperative day, mean astigmatism decreased to 0.954±0.494D with $p<0.01$, and finally after 1 Month there was significant reduction of pre-operative astigmatism to 0.583±0.413D with $p<0.0001$. So, the mean pre-operative astigmatism decreased significantly in the successive post-operative days.

Conclusion: Toric Intraocular lens implantation in phacoemulsification surgery can correct pre-existing corneal astigmatism significantly after one month of surgery.

Keywords: Toric, Intraocular lens, Phacoimulsification, Cornea, Astigmatism

Abbreviation: D-Diopter, PC-Posterior chamber, IOL- Intraocular lens, ARC-Age related cataract, SD-Standard deviation, K1-Flat keratometry, K2-Steep keratometry

Introduction

Cataract is the leading cause of visual impairment and blindness in the world. There is various method of cataract extraction such as, Intracapsular cataract extraction (ICCE), extracapsular cataract extraction (ECCE), small incision cataract surgery (SICS) and Phacoemulsification cataract surgery.[1]

Currently, phacoemulsification with posterior chamber intraocular lens (PCIOL) implantation is the most popular treatment modality for cataract. In recent years, phacoemulsification through a clear corneal tunnel tunnel incision has become increasingly popular due to ease of the technique, reduced length

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of the surgery, little or no trauma to the conjunctiva, quick rehabilitation of vision and the reduced risk of wound leakage and endophthalmitis.[2]

Astigmatism occurs when the patient's cornea is steeper in the vertical axis (with-the-rule astigmatism) or in the horizontal axis (against-the-rule astigmatism)[3] when the principal meridians are perpendicular. A third type of regular astigmatism, oblique astigmatism, occurs when the steepest curve lies between 120–150° and 30–60°. When replacing a lens during cataract surgery, astigmatism can either be corrected by prescription glasses, contact lenses, corneal relaxing incisions, astigmatic keratotomies, limbal relaxing incisions, excimer laser ablation, and toric IOL implantation. Toric intraocular lens provide a safe and predictable alternative to reduce or eliminate refractive astigmatism with a cylindrical correction, offering patients with preexisting corneal astigmatism optimal distance visual acuity without the use of spectacles or contact lenses.[4]

A toric lens is one whose two surfaces differ, with one being spherical in shape and the other being toroidal. Such a shape may allow for the correction of both with-the-rule (WTR) and ATR astigmatism depending on placement of the toroidal axis.[5]

Visual rehabilitation after phacoemulsification largely depends on corneal astigmatism.[6] So it should be addressed properly. Around 50% of people have astigmatism of about 0.25D to 0.50D. Astigmatism can be classified into regular and irregular astigmatism.[7] Besides pre-existing astigmatism, surgically induced astigmatism is also a subject of concern which largely depends on the type, site and length of incision and suture closure technique.[8]

The smaller the incision, the less is the corneal astigmatism. With the shortening of corneal tunnel incisions from 5.5 mm to 3.2 mm, 2.8 mm, 2.4 mm and 2.2 mm visual function postoperatively has steadily increased.[9] Smaller incisions provide less astigmatism as well as better self-sealing of wound.[10]

Most of patients come to our hospital with the complaints of dimness of vision. Among them cataract with astigmatism is one of the important causes for this. For the correction of astigmatism during cataract surgery toric IOL implantation offers a predictable, stable and safer way to reduce pre-existing astigmatism. Here we adopted phacoemulsification and PCIOL implantation with the 2.4 mm on axis clear corneal incision. Multiple factors may influence the final outcome and the degree of residual astigmatism if any. While our incisions for phacoemulsification is thought to cause a predictable degree of flattening, patient's age, pachymetry, corneal diameter, tilted IOL, wound healing and other factors can cause astigmatism to vary significantly. A large degree of IOL optic tilt is seen typically in cases with a compromised capsular bag or in asymmetric IOL placement with one haptic in the bag with the other in the sulcus. But even in a perfectly done cataract surgery, the patient's healing response, scarring and fibrosis can cause an IOL to tilt enough to induce some astigmatism. The aim of this study is to determine the amount of postoperative residual astigmatism and visual outcome with Toric IOL implantation during phacoemulsification.

Materials and methods:

A hospital based prospective observational study was conducted at the department of Cataract in the National Institute of Ophthalmology and Hospital, Sher-e-Bangla Nagar, Dhaka, and the duration of study was from July, 2013 to June, 2014. Among 30 eyes of 28 patients who came with the complaints of dimness of vision due to cataract with variable amount of astigmatism (range 1.5 to 3.5D). Those who came with any other ocular pathology or history of previous ocular surgery were not included in this study. Cataract extraction were done by phacoemulsification surgery with implantation of Toric IOL. All the surgeries were done with INTREPID Micro-Coaxial system using the INFINITY Vision system by the same surgeon under local & topical anaesthesia. The cornea was marked with a marker pen at 12 O'clock position (90 degree) for each eye before anaesthesia was given to avoid anaesthesia related cyclotorsion. Peroperatively, the orientation of axis is determined in left eye; temporal 0,

superiorly 90 nasal 180 and right eye; nasal o, superiorly 90 and temporal 180. The clear corneal tunnel incision was performed with the side-port 70 degree apart and to the left side of main incision. The tunnel incision was done in all patients with a 2.4mm Webal Edge knife and side-port with 1.2mm Webal Edge knife. After phacoemulsification Toric IOL was implanted in the capsular bag. All incision was left suture less and were sealed by corneal stromal hydration. Patients follow up was done on 1st POD, 1st week and 1st month after surgery for all cases. Preoperative and postoperative keratometry readings were made by autorefractokeratometer. Analysis of the astigmatism was restricted to the keratometric readings. The change in the keratometric cylinder was examined by simple subtraction method of calculating cylinders without regards to axis.

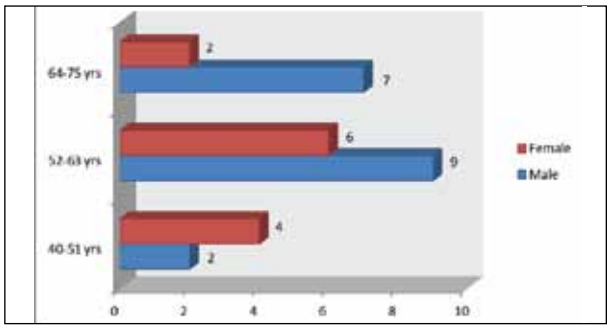
Main outcome measures were assessed by preoperative uncorrected visual acuity, postoperative uncorrected visual acuity on 1st POD, after 1 week and 1-month, preoperative keratometry, preoperative astigmatism, postoperative uncorrected keratometry on 1stPOD, after 1 week and 1month, postoperative uncorrected astigmatism on 1stPOD, after 1 week and 1month. Data was collected in a predesigned data collection sheet and then compiled accordingly. Appropriate statistical analysis was done using computer-based software SPSS program 13.0 version.

Ethical measures: Patients were informed about the study purposes and how they have to participate for the study and the possible complications related with the surgical procedure. They were assured and confirmed that no way their normal treatment would be hampered for this study. And at any time, they could withdraw themselves for any reason without explanation. And any private information gathered for this study will be kept confidential. Informed written consent has been taken from patient's legal guardian prior to data collection.

Results

We assessed 30 eyes of 28 patients in this study. The age range was from 40 years to 75 years. The most of the cases was above 50 years of age. The male was 60% and female was 40% [Figure-1].

Figure-1: Bar diagram showing distribution of demographic profile of the study patients



Due to clear corneal incision during cataract surgery, the steep meridian pre-operative mean keratometry was 44.329D (P value<0.01). Postoperative mean keratometry readings were 44.196D at 1st POD, and 43.97D at 1 month of surgery (P value <0.001) [Table-1].

Table-1: Pre-operative and Post-operative keratometry of steep axis with comparison

Pre operative(D) Mean±SD	Post operative(D), mean ±SD			Paired-t test
	1st POD	7thPOD	30th POD	P Value
44.329±1.473	44.196±1.419			*p*=0.001
		44.033±1.404		*p*<0.001
			43.971±1.431	*p*<0.001

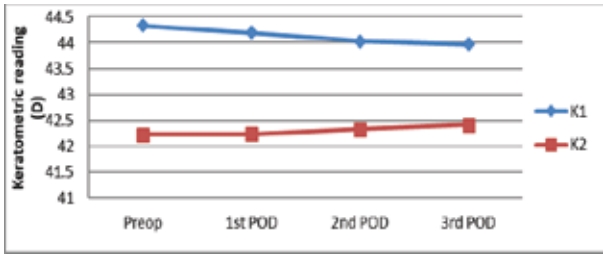
Due to clear corneal incision during phacoemulsification surgery, the steep meridian became flat significantly from pre-operative keratometry to post operative keratometry. On the other-hand the flat meridian became steeper from pre-operative keratometry to 30thpost operative keratometry. [Table-2].

Table-2: Pre-operative and Post-operative keratometry of flat axis with comparison

Pre operative(D) Mean±SD	Post operative(D), mean ±SD			Paired t-test
	1st POD	2ndPOD	3rdPOD	P Value
42.225±1.471	42.233±1.515			*p*=0.742
		42.333±1.492		*P*=0.001
			42.421±1.501	*p*<0.001

The preoperative visual status was Hand Movement (HM) to 1/60 in 10.7% of patients, 2/60 to 6/60 was in 60 % of patients; 6/36 to 6/24 was in 23.3% of patients. Visual acuity in the 1stpost operative day were 6/6 in 6 (20%) cases, 6/9 in 13 (43.3%) cases, 6/12 in 8 (26.7%) cases, 6/18 in 2(06.7%) and 6/24 in 1 (03.3%) case. The visual acuity in the 7th post operative day were 6/6 in 14 cases (46.7%), 6/9 in 9 cases (30%), 6/12 in 6 cases (20%) and 6/18 in 1 (03.3%) case (Table 3.3). The final visual outcome in the 30th post operative day were 6/6 in 21 cases (70%), 6/9 in 7 cases (23.3%) and 6/12 in 2 (06.7%) cases.

Figure-2: Pre-operative and post operative keratometric (K1 and K2) reading changes



The flat axis become steeper from preoperative readings to final postoperative readings, whereas the steeper meridian became flat [Figure-2].

Preoperative mean astigmatism was 2.104D. After 1 Month, there was significant reduction of pre-operative astigmatism to 0.583D with P value <0.0001. So, the mean astigmatism was decreased significantly in the successive post-operative days [Table-3].

Table-3: Pre-operative and Post-operative astigmatism with comparison

Pre operative(D) Mean±SD	Post operative(D), mean ±SD			**Paired t-test**
	1st POD	7thPOD	30th POD	**P Value**
2.104±0.319	0.954±0.494			*P*<0.001
		0.608±0.407		*p*<0.001
			0.583±0.413	*p*<0.0001

Discussion

Cataract surgery is one of the types of refractive surgery. But the corneal astigmatism plays an important role in ultimate post-operative visual status of the patient. The visual status of an individual depends not only on the visual acuity, but also on field of vision, colour vision, contrast sensitivity, glare sensitivity and binocularity. The clarity of image in astigmatism is never as good as those having no astigmatism. Astigmatism significantly affects patient's independence, quality of life and well-being. Considering these facts, many studies are going on in recent time to minimize the pre-existing corneal astigmatism by adopting different procedures during cataract surgery.

In this study the effect on pre-existing corneal astigmatism by implantation of Toric intraocular lens during cataract surgery and residual astigmatism after surgery is assessed. The toric IOL was devised by Shimizu et al. in 1994 and has been used clinically since then.[11]

In this study, the age range was from 40 years to 75 years. The peak incidence of cataract was among 52- 63 years. The age-related cataract is common as early as the fifth decade of life, with 11.5% of people aged 43–54 years having some evidence of cortical opacity.[12] Our study also more or less corresponds with it.

Female were more affected by age related cataract, about 60.1%[13] whereas in our study we found an opposite scenario, male were 18 (60%) and female were 12 (40%). This difference may be due to female patients in our country deprived of proper treatment and approach to a tertiary hospital is difficult.

The decreased visual acuity in early post operative day may be due to residual corneal astigmatism as wound was not healed. Visual acuity is improved after 1 month may be due to correction of residual astigmatism as wound was healed. This study was compatible with the result of another study on cataract patients with high degree of astigmatism.[14] They showed uncorrected distant VA of 20/40 or better in 83% of eyes and 20/30 or better in 50% of eyes.

Due to clear corneal incision, the steep meridian became flat significantly from pre-operative keratometry 44.329±1.473D (mean±SD) to 30thpost operative keratometry 43.971±1.431 D (mean±SD) having p<0.001. On the other hand, the flat meridian became steeper from pre-operative keratometry 42.225±1.471 D (mean±SD) to 30thpost operative keratometry 42.421±1.501 D (mean±SD) having p<0.001 (Table -3.6). So, the pre-existing astigmatism reduced gradually. The test of significance was done by Paired- Sample T Test. This study was compatible with Beltrame et al. in 2001, who showed significant wound related flattening and non-orthogonal steepening at 2 opposite radial sectors induced by different oblique cataract incision.[15]

Preoperative mean astigmatism [Mean±SD] was 2.104±0.319 diopter (D), after the first postoperative day, mean astigmatism decreased to 0.954±0.494 D with p<0.01, after 1 week mean astigmatism reduced to 0.608±0.407 D with p<0.001 and finally after 1 Month there was significant reduction of pre-operative astigmatism to 0.583±0.413 D with p<0.0001 (Table -3.7). So, the mean pre-operative astigmatism decreased significantly in the successive post-operative days (Fig 3.4). This study was compatible to other study14 who showed after implantation of Toric

IOL, residual refractive cylinder was less than 0.75 D in 62% of eyes and less than 1.00 D in 81% of eyes.

The limitations of the study included small sample size, single center study, short follow up times, absence of control group and long-term results couldn't be assessed. Epidemiological studies should be carried out to define the prevalence of the problem in Bangladesh. This will help in subsequent management plans.

Cataract surgery as a form of refractive surgery demands uncorrected quality vision postoperatively. Ophthalmologists planning to bring quality vision for the patient after cataract surgery by phacoemulsification would be prudent to adopt the best suited procedure to minimize the pre-existing astigmatism for the individual patient. Even if patients have residual astigmatism after cataract surgery Ophthalmologists have to treat accordingly.

Conclusion:

The Toric IOL implantation during cataract surgery can be a good option for correction of pre-existing corneal astigmatism significantly in phacoemulsification surgery. However, the complete and perfect correction of astigmatism is not yet obtained in all cases. To minimize postoperative residual astigmatism, we have to evaluate preoperative and per operative risk factors carefully and correct postoperative residual astigmatism. But a study comprising larger study population of longer duration is necessary to draw a better inference.

Conflict of interest: none.

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