

# A study of relationship between the keratometric and refractive astigmatism in pseudophakia

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## Abstract

**Introduction:** The goal of current refractive cataract surgery is an excellent uncorrected visual acuity (UCVA) in all fixation ranges, which requires a zero postoperative refractive astigmatism (RA). This goal may be reached by implantation of toric lenses and by a variety of corneal procedures, such as on-axis phaco incisions, limbal relaxation incisions, anterior keratotomy and postoperative corneal laser touch-ups. **Objective:** To study relationship between the keratometric and refractive astigmatism in pseudophakia. **Materials and Method:** The present study was conducted in the Mohan Eye Institute, New Delhi. The duration of study was from 1st December 2011 to 30th May 2012. Following inclusion and exclusion criteria was used to select the study patients. All patients, irrespective of age or sex who underwent a phacoemulsification surgery with a posterior chamber foldable intraocular lens implant for immature senile cataract in the study institute during the given duration. Incision size in all the patients was maintained at 3.2 mm with a keratome and it was a clear corneal incision. **Results:** Out of 91 patients, 58.24% were males and 41.76% were females. The mean age of the study patients was 64±8yrs. All subjects underwent phacoemulsification with 3.2mm corneal incision superotemporal (53%) and infero-temporal (47%) approach with foldable intraocular lens implants. The patients were followed up for a period of 8wks. There was a statistically significant change in refractive astigmatism from pre-op state to post-op state. In pre-op patients total refractive astigmatism was about -1.39 D (±0.53 D) whereas it reduced to -0.95 D (±0.73 D) **Conclusion:** Hence we conclude that, astigmatism in human eyes is caused by several factors other than cornea and lens.

**Keywords:** keratometric, refractive astigmatism, pseudophakia.

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## INTRODUCTION

Cataract is derived from the Latin word “cataracta” meaning waterfall and that from the Greek “kataraktes” meaning “down rushing”. The goal of current refractive cataract surgery is an excellent uncorrected visual acuity (UCVA) in all fixation ranges, which requires a zero postoperative refractive astigmatism (RA). This goal may be reached by implantation of toric lenses and by a variety of corneal procedures, such as on-axis phaco

incisions, limbal relaxation incisions, anterior keratotomy and postoperative corneal laser touch-ups. Following cataract surgery, RA is predominantly determined by the total corneal astigmatism. It is therefore important to establish a numerical correlation between corneal and refractive astigmatism. Ocular refractive astigmatism (RA) is measured with manifest refraction. Ocular RA is caused by the toricity, tilt or lack of axis alignment of the ocular refractive surface.<sup>1</sup> Anterior corneal astigmatism (ACA) refers to the toricity of the anterior corneal surface, as measured with keratometry or videokeratography.<sup>2</sup> Duke-Elder defines the residual astigmatism as the astigmatism due to the posterior surface of the cornea, the surfaces of the lens, decentration and the variability of the refractive index of the lens.<sup>3</sup> In current ophthalmology, ‘residual astigmatism’ denotes astigmatism left over from refractive procedures. Control of astigmatism is a very important aspect of the modern refractive cataract surgery. Advancements in cataract surgery include decreasing the size of incision, use of toric Intra Ocular

Lens implants (IOL), and site of placement of incision to reduce the postoperative astigmatism. From ICCE to micro incision phacoemulsification, corneal incision size was reduced considerably and as a result the need of sutures and postoperative keratometric astigmatism. In a human eye total refractive astigmatism has two components, keratometric astigmatism and intraocular astigmatism. And it is considered that intraocular astigmatism is mainly due to the lenticular astigmatism. In psuedophakic eyes it is assumed that refractive astigmatism is synonymous with keratometric astigmatism. In this study we will try to understand the causes of astigmatism in psuedophakic eyes and to determine whether keratometric astigmatism is the sole cause of astigmatism in these eyes.

**MATERIALS AND METHOD**

The present study was conducted in the Mohan Eye Institute, New Delhi. The duration of study was from 1st December 2011 to 30th May 2012. Following inclusion and exclusion criteria was used to select the study patients.

**Inclusion Criteria**

All patients, irrespective of age or sex who underwent a phacoemulsification surgery with a posterior chamber foldable intraocular lens implant for immature senile cataract in the study institute during the given duration.

**Exclusion Criteria**

- Patients with preoperative astigmatism of > 2 Diopter (D).
- Patients with pre - existing corneal opacity (s).
- Patients with corneal degenerations, dystrophies or ectasia.
- History of glaucoma, intraocular inflammation, retinal detachment, macular degenerations or retinopathy.

- Previous history of intraocular or corneal surgery.
- Abnormal iris or pupil deformation.
- Complicated cataract surgery or postoperative macular edema.

Thus total of 91 eyes of 91 patients were examined and studied in the present study. A detailed history was taken regarding systemic and ocular complaints. History of trauma, diabetes or any other systemic illness or drug intake was ruled out. History of diminution or blurring of vision, any problems in reading or near work was taken. General physical examination and systemic examination was done in all the patients. Assessment of patient’s best corrected visual acuity (BCVA) was done using Snellen’s Chart. Intraocular pressures (IOP) were noted with applanation tonometer. Dilated retinoscopy was done in cases where it was possible and preoperative refractive astigmatism was assessed. Fundus bio-microscopy examination was carried out by +90D lens. Preoperative Keratometry was done manually using a Bausch and Lomb type keratometer. All the surgeries were performed under local anesthesia using a peribulbar block injection of lignocaine 2% given inferolaterally. All the patients underwent a phacoemulsification surgery. Incision size in all the patients was maintained at 3.2 mm with a keratome and it was a clear corneal incision. First follow up was done at 3 weeks after the date of surgery. Patient’s BCVA was noted unaided and with a pinhole. Keratometry of the operated eye was noted using a Bausch and Lomb type keratometer. Instrument was calibrated before every use. A dilated retinoscopy was done using plane mirror in the retinoscope (Heine’s). Second follow up was done at 8 weeks after the date of surgery. Patient’s BCVA with and without glasses was noted. Keratometry with Bausch and Lomb type keratometer and a dilated retinoscopy using plane mirror in the retinoscope (Heine’s) were done and findings noted.

**RESULTS**

**Table 1:** Demographic characteristics of the patients

Characteristics	Frequency (n=91)	Percentage
Sex	Male	53 58.24
	Female	38 41.76
Age	≤55	13 14.29
	56- 65	34 37.36
	>65	44 48.35
Eye involved	Right eye	43 47.25
	Left eye	48 52.75

In the present study we evaluated 91 eyes of 91 patients, out of them 58.24% were males and 41.76% were females. The mean age of the study patients was 64±8yrs. Right eye was involved in 47.25% patients whereas left eye was involved in 52.75% patients.

**Table 2:** Changes in keratometric astigmatism and total astigmatism at all time points

	Preop K – astig.	Preop Total - astig.	3 weeks Post op K-Astig.	3 weeks Post op Total-Astig.	8 weeks Post op K-Astig.	8 weeks Post op Total-Astig.
N	91	91	91	91	91	91
Minimum	0	0	0	0	0	0
Maximum	-1.75	-2.75	-1.50	-2.50	-1.50	-2.50
Range	-1.75	-2.75	-1.50	-2.50	-1.50	-2.50
Mean	-0.77	-1.39	-0.75	-0.95	-0.75	-0.95
Median	-0.75	-1.50	-0.50	-0.75	-0.50	-0.75
SD	0.35	0.53	0.62	0.73	0.62	0.73

The compared the effect of surgery on keratometric astigmatism and evaluated the pre-op value of  $-0.77 \pm 0.35$  D and the post-op value of  $-0.75 \pm 0.62$  D keratometric astigmatism. And there was statistically insignificant change in keratometric astigmatism. But there was a statistically significant change in refractive astigmatism from pre-op state to post-op state. In pre-op patients total refractive astigmatism was about  $-1.39 \pm 0.53$  D whereas it reduced to  $-0.95 \pm 0.73$  D. In post-op patients we also compared the keratometric astigmatism at 3wks and 8wks after surgery and there was statistically insignificant change.

**Table 3:** Mean percentage of preoperative and postoperative keratometric astigmatism in total astigmatism

keratometric astigmatism in total astigmatism	
Preoperative	53.11% $\pm$ 14.96%
Post operative 3 week	62.83% $\pm$ 33.53%
Post operative 8 week	62.83% $\pm$ 33.53%

Out of the 91 patients, the mean preoperative percentage of keratometric astigmatism in the total astigmatism was  $53.11 \pm 14.96\%$ . The range of preoperative percentage of keratometric astigmatism in total astigmatism was from 0 to 66.67%. It was observed that after post operative 3 weeks the mean postoperative percentage of keratometric astigmatism in total astigmatism was  $62.83 \pm 33.53\%$  with range from 0 – 100 %. Whereas after post operative 8 weeks mean postoperative percentage of keratometric astigmatism in total astigmatism was constant as of after 3 weeks i.e.  $62.83 \pm 33.53\%$ .

**Table 4:** Table showing results by Wilcoxon Signed Rank Test

Preoperative vs. postoperative percentage of keratometric astigmatism in total astigmatism	(p= 0.0203, significant).
The median of differences between pre op total astigmatism and post op total astigmatism	(p= 0.000, significant).
The median of differences between pre op keratometric astigmatism and post op keratometric astigmatism	(p= 0.775, not significant).

Wilcoxon signed rank test was applied on the data and we compared the percentage of keratometric astigmatism in total astigmatism in pre-op and post-op patients.

## DISCUSSION

The present study was conducted in the department of ophthalmology of Mohan Eye Institute, New Delhi with the objective to study the relationship between the keratometric and refractive astigmatism in pseudophakia. In the present study we evaluated 91 eyes of 91 patients with a mean age of  $64 \pm 8$  yrs. It was seen that 58.2% were males and 41.8% were females. All subjects underwent phacoemulsification with 3.2mm corneal incision superotemporal (53%) and infero-temporal (47%) approach with foldable intraocular lens implants. The patients were followed up for a period of 8wks. In our study we compared the role of keratometric astigmatism in pre-op and post-op patients (3 wks and 8wks after surgery). In the present study, we found postoperative refractive astigmatism is not same as post-op keratometric astigmatism in both the magnitude and axis. Postoperative keratometric astigmatism accounts for about 79% of total astigmatism. About 20% astigmatism

is due to unknown factors as the lenticular astigmatism has been eliminated. These findings indicate that the factors other than keratometric astigmatism also produce astigmatism in pseudophakic eyes. It was seen that out of the mean preoperative percentage of keratometric astigmatism in the total astigmatism was  $53.11 \pm 14.96\%$  whereas after post operative 3 weeks the mean postoperative percentage of keratometric astigmatism in total astigmatism was  $62.83 \pm 33.53\%$ . Thus keratometric astigmatism was the major component of total astigmatism. Similar findings were also reported by Teus *et al*<sup>4</sup>, Mendicutte J *et al*<sup>5</sup>, Rui z- Mesa *et al*<sup>6</sup> and Bauer NJC *et al*<sup>7</sup> in their study. In our study there is not much change in keratometric astigmatism in preop and post-op patients but there is significant change to refractive astigmatism. The results are in contrast with the study conducted by Sharifi A *et al*<sup>8</sup> who concluded that there is no significant difference in postoperative keratometric and refractive astigmatism in most of the eyes, about 10%

show >1D change in these measurements. Surgical techniques, most importantly incision placement and incision size also affect postoperative keratometric astigmatism and finally the total refractive astigmatism. Ideally as we call the cataract surgery a refractive surgery, total astigmatism should come down to zero. So both the components of astigmatism that is keratometric astigmatism should be tackled. Even in our study we could not eliminate the keratometric astigmatism due to some possible lacunae in our technique. First of all instead of following the fixed incision site we should have placed the incision on steeper axis. But there is controversy in literature regarding the placement of incision. Studies reveal that clear corneal temporal incision induce less surgically induced astigmatism than clear corneal incision on the steeper axis. However there is no significant difference in UCVA and BCVA. The various studies should be performed to increase our knowledge of the predictability and the optical quality of the currently available methods to correct astigmatism in pseudophakic eyes.

## CONCLUSION

Hence we conclude that, astigmatism in human eyes is caused by several factors other than cornea and lens. The reason factors other than keratometric astigmatism also produce astigmatism in pseudophakic eyes.

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