

Original Research Article

Keratometric changes in a population-based study: a comparative analysis of pre- and post-cataract surgery outcomes

Jamshed Ali^{1*}, Mariyam Khan¹, Salal Khan¹, Sunil Kumar Gupta¹, Ali Saeed², Kamal Pant³

¹Department of Optometry, Era University, Lucknow, Uttar Pradesh, India

²Department of Optometry, FBDO, B.OPT, Uttar Pradesh, India

³Department of Optometry, UPUMS, Saifai, Etawah, India

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*Correspondence:

Dr. Jamshed Ali,

E-mail: alijamshed429@gmail.com

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ABSTRACT

Background: This study aims to evaluate the distribution of keratometry in cataract patients to know the variation in pre and post of small incision cataract surgery (SICS). To determine the variation in pre and post of small incision cataract surgery (SICS) using Bausch and Lomb keratometry instrument.

Methods: This is a cross sectional study, undertaken at secondary centre of Dr. Shroff's Charity eye hospital Mohammadi. Two hundred patients will be selected for keratometry in pre and post of SICS. Small incision cataract surgery (SICS) will be done with straight incision with back cut technique using 1.5 mm incision from limbus and 6.0 mm optic PMMA IOL implantation. All surgeries will be performed by a single surgeon, surgical procedures being standardized. Results will evaluate at the end of the study.

Results: Out of the total 200 patients 75 (38%) are male and 125 (63%) are female with the age Ranging from 40-80 years. The data are further divided into 2 subgroups (>50 and <50 years) and variations in pre and post of SICS are calculated for individual age Subgroups and gender. Out of total 200 patients in post op K1 reading subtraction the absolute variation value ≤ 1.00 are found in 185 patients (92.50%) while the absolute variation value > 1.00 are found in 15 patients (7.50%). In post op K2 reading subtraction the absolute variation value ≤ 1.00 are found in 178 patients (89.00%) while the absolute variation value > 1.00 are found in 22 patients (11%).

Conclusions: Most frequently observed pre-existing corneal astigmatism in this study is the corneal astigmatism or absolute variation value in K1 are $\leq 1.00D$ 93% and $> 1.00D$ in 8%. And absolute variation value in K2 are $< 1.00D$ 89% and $> 1.00D$ 11%. The change in K reading are in males 38% and females 62% > 50 years age group. On the other hand, the K reading are decreased to 35% in males in < 50 years age group and increase to 65% in females in < 50 years age group. As the age advances the astigmatism becomes more common which is more evident in females as compared to males. This can be easily corrected with appropriate measures like corneal relaxing incisions, excimer laser refractive procedures, femto laser assisted astigmatic keratectomy and toric IOL implantation.

Keywords: Astigmatism, Awareness, Cataract, Keratometry, Small incision cataract surgery

INTRODUCTION

It is estimated that there are 12.5 million visually impaired people in India, of whom 50-80% are blind due to cataracts.^{1,2} Adding to this delay, an additional 3.8 million people become blind due to cataracts each year.³

Modern cataract surgery aims not only to improve vision but also to provide good unaided visual acuity (VA). Postoperative astigmatism is one of the

obstacles to achieving good visual acuity without spectacles after cataract surgery. Correction of astigmatism error and control of surgically induced

astigmatism (SIA) are now an integral part of cataract surgery. Small incision cataract surgery (SICS) has been a boon because it has been said that the smaller incision and lack of sutures causes minimal astigmatism. Sutureless SICS has significantly reduced postoperative astigmatism. It also aids in early rehabilitation by stabilizing refraction after surgery.

There are several variables that affect the amount of surgically induced astigmatism. Basically, this place (square film, restriction or a strong film), direction (excellent, temporary or super-temporary), width, depth, incision form. It has been reported that the depth of the incision has little effect on the amount of the induced astigmatism. On the other hand, the location and orientation of the wound have a significant impact on the outcome. According to the rule, astigmatism occurs when the corneal curvature is most pronounced in the vertical meridian. Conversely, unlike the ruler, astigmatism is present when the steepest meridian of the cornea is horizontal. The superior meridional cut produces more astigmatism against the ruler. More common in elderly patients. While temporal incision causes “rule astigmatism”. The result is improved uncorrected vision.

Cataracts are a leading cause of blindness and the only treatment is surgery. Small incision cataract surgery (SICS) is the most commonly used and effective surgical method for the treatment of cataract worldwide. Accurate measurement of axial length, keratometry, anterior chamber depth and corneal diameter before cataract surgery is essential to obtain accurate power of the implanted intraocular lens (IOL) and control the postoperative diopter (D) value plus or minus 0.50 D and the postoperative diopter (D) value to obtain satisfactory postoperative refractive results and improve the quality of vision in cataract patients.^{4,5}

Therefore, the aim of our study is to evaluate the distribution of keratometry in the population based on before and after cataract surgery and to determine the prevalence of corneal astigmatism using keratometry device before small incision cataract surgery (SICS) in cataract patients at Shroff's Mohammadi Charity Eye Hospital to provide reference materials for the improvement of cataract surgery. cataract and intraocular lens design. The corneal measurement method is also known as an ophthalmology (kerato -corn membrane, metreal-measurement). The corneal measurement is a procedure that can measure the curvature on the front of the cornea. The optical surface of the cornea is the first and the most important optical surface of the eye and its center thickness is about 550 μm , its vertical diameter is about 11.5 mm and its horizontal diameter is 12.5 mm.⁶ The posterior corneal radius is 6.5 mm on average that is lower than the anterior corneal radius which is mm.⁷⁻⁹ Measurement of curvature of cornea for contact lens fitting. IOL power calculations (pre-op cataract surgery workup) measurement of corneal astigmatism. Determination of irregular astigmatism like keratoconus

and corneal scarring. To access integrity of cornea or tear film.

Keratometry along with other ocular parameters like axial length, the curvature and thickness of crystalline lens, and anterior chamber depth can influence the degree and type of refractive error. An abnormal value of keratometry can lead to a sequence of severe ametropia and therefore amblyopia in young age. The difference between keratometry in principle meridians is the factor of corneal astigmatism. Knowledge of keratometry is therefore crucial for understanding the state of refractive error.

It is based on the principle that the anterior surface of the cornea acts as a convex mirror, and the size of the image formed directly depends on the curvature of the cornea. Thus, knowing the size of the image formed, the curvature of the cornea can be calculated.

Keratometry measurements are performed using keratometers, corneal topography and pentakem. The most commonly used keratometry is the keratometer, such as the Bausch + Lomb Keratometer, Auto Refractometry Keratometer, etc. Corneal topography is designed to provide a more accurate and comprehensive assessment of the corneal surface. The Pentacam uses a rotating Scheimpflug camera and light source to capture images of the anterior and posterior surfaces of the cornea on different meridians around the optical axis. This study will investigate different age groups through a population-based approach and build a database that will allow us to investigate the normal changes in keratometry that occur before and after cataract surgery. One of the most important aspects of this study is that it allows us to compare and evaluate keratometry across the lifespan.

METHODS

Data acquisition

This are a hospital-based prospective cross sectional study using data collected in the Advanced Clinical Center for cataract surgery, Dr. Shroff's charity eye hospital. All registered patients had at least 1 eye of pre and post of cataract surgery. None of the eyes had any corneal diseases such as keratoconus, keratoconjunctivitis, corneal ulcer etc. All medical data are collected from September 1, 2021 to July 31, 2022. The number of patient visits at the time of surgery and after 1 month of surgery are counted. Visits for other purposes such as making surgery appointments or referrals are not counted. Corneal curvature changes in all patients are evaluated pre operatively and 1-month post operatively with keratometry. Keratometry are measured in two meridians: that is, flat keratometry (K1) and steep keratometry (K2).

For these data, patients age is recorded by comparing the date of birth and the date of the examination. The BCVA are measured with a Snellen chart at 50 cm. Ocular axial length (AL), Anterior chamber depth (ACD) of each

cataract affected eye are measured with IOL Master (TOPCON ALADDIN) and also use immersion technique.

Small incision cataract surgery (SICS) will be done with straight incision with back cut technique using 1.5 mm incision from limbus and 6.0 mm optic PMMA IOL implantation. All surgeries will be performed by a single surgeon, surgical procedures being standardized.

Data cleansing

To decrease the random errors caused by the frequent measurements of corneal curvature, the manual keratometer (Bausch and lomb) are used to measure the changes in the value of k1 and k2. Small incision cataract surgery, either sex is included. Patients age less than 40 years are excluded because our research is focused on adults. The patients with all type of

Ocular diseases, Phacoemulsification (PHACO), Extracapsular cataract extraction (ECCE), Intracapsular cataract extraction (ICCE), High astigmatism are excluded. Routine eye examinations are performed before surgery, including visual acuity, refraction, tonometry, slit lamp evaluation, and dilated fundus evaluation. The procedures are fully explained to each patient. In addition, a value of 47.2 D or greater are also excluded to avoid the influence of keratoconus. After these steps, 200 patients met the inclusion criteria and are used for the final analyses.

Data grouping and examinations

We analyzed the corneal curvature and changes in the value of k1 and k2 at different ages for both sexes. We divided the data by patient ages with decade intervals and observed the distribution of keratometry in pre and post of cataract surgery at the different age groups. Of the total 200 patients 75 (38%) are male and 125 (63%) are female with the age ranging from 40-80 years. The data are further divided into 2 subgroups (>50 and <50 years) and variations in pre and post of SICS are calculated for individual age subgroups and gender.

Ethical approval

The procedures used in this prospective cross sectional study conformed to the tenets of the Declaration of Dr. Shroff's Charity eye hospital Mohammadi (secondary center). The institutional review board and ethics committee approved the methods of medical data collection. All patients provided written informed consent.

Statistical analysis

The study being a descriptive one, I have provided the detailed descriptions of all variables of the dataset. Most of the variables I studied are categorical. The categorical

variables are summarized by their frequency and percentages, and the continuous variables by their means and standard deviations. To compare the distribution of keratometry in a population based pre and post of cataract surgery, we applied the non-parametric Wilcoxon test. Statistical analysis is done using R version 4.2.0. p value 1.000 (chi-square).

RESULTS

Of the total 200 patients 75 (38%) are male and 125 (63%) are female with the age Ranging from 40-80 years (Figure 1). The mean age are 65 years. The data are further divided into 2 subgroups (>50 and <50 years) and variations in pre and post of SICS are calculated for individual age Subgroups and gender. Out of total 200 patients in post op K1 reading subtraction the absolute variation value ≤ 1.00 are found in 185 patients (92.50%) while the absolute variation value > 1.00 are found in 15 patients (7.50%). In post op K2 reading subtraction the absolute variation value ≤ 1.00 are found in 178 patients (89.00%) while the absolute variation value > 1.00 are found in 22 patients (11%).

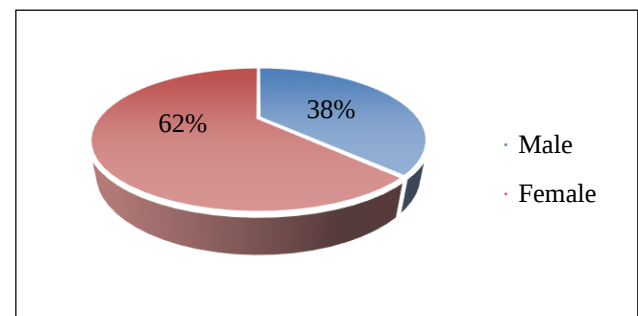


Figure 1: Total percentage of male/ female patients.

Table 1: Gender distribution and post op k1 & k2 reading with association of absolute variation value ≤ 1.00 and absolute variation value > 1.00 .

Total patients	Male	Female	Total
male/female	75	125	200
Age >50	Male	Female	Total
male/female	67	110	177
Age <50	Male	Female	Total
male/female	8	15	23
Post op K1 Reading subtraction	Sex	Absolute variation value ≤ 1.00	Absolute variation value ≤ 1.00
	Male	69	6
	Female	116	9
	Total	185	15
Post op K2 Reading subtraction	Male	67	8
	Female	111	14
	Total	178	22

The number of women in this study are greater than the number of men in each group (Table 1). Although the number of patients with severe annual growth and the annual growth rate both increased with increasing age the significant interaction ($p=1.000$) between age and sex suggests that the corneal curvature in eyes with worse BCVA are greater than in eyes with better initial BCVA, but this difference gradually increasing with increased

age and are slightly greater in eyes with better BCVAs. The mean value of k1 and k2 in women are 125 (63%) and the mean value of k1 and k2 in men are 75 (38%) (Table 2). More than >50 and less than <50 age group in males and females is not much variation. It was analysed by chi square test (p value =1.000) which is highly significant (Table 2 and 3), (Figure 2 and 3).

Table 2: Showing the variation among the population and post op K1 reading subtraction.

Post op K1 reading subtraction	Absolute variation value ≤ 1.00	Absolute variation value > 1.00	Total	Absolute variation value ≤ 1.00 , %	Absolute variation value > 1.00 , %
Male	69	6	75	92.00	8.00
Female	116	9	125	92.80	7.20
Total	185	15	200	92.50	7.50

Table 3: Showing the variation among the population and post op K1 reading subtraction.

Post op K2 reading subtraction	Absolute variation value ≤ 1.00	Absolute variation value ≥ 1.00	Total	Variation value < 1.00 , %	Variation value > 1.00 , %
Male	67	8	75	89.33	10.67
Female	111	14	125	88.80	11.20
Total	178	22	200	89.00	11.00

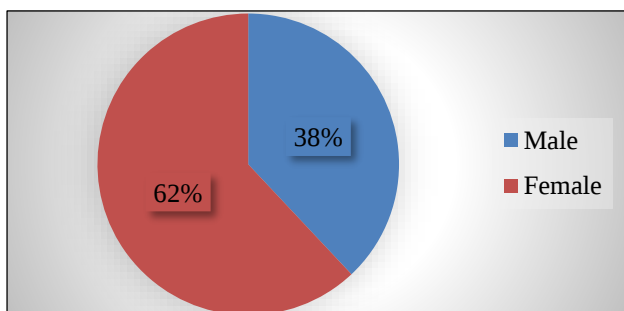


Figure 2: Age >50 male/ female percentage.

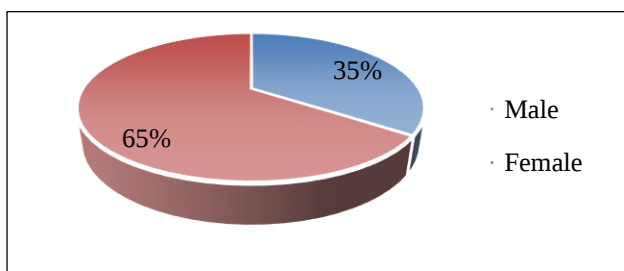


Figure 3: Age <50 male /female percentage.

To determine the risks associated with severe changes in post op k1 reading and post op k2 reading, we examined the sex, age, and k reading. The post op k1 reading subtraction in mean absolute variation value ≤ 1.00 is 185 (92.50%) and mean absolute variation value > 1.00 is 15 (7.50%). The post op k2 reading subtraction in Mean absolute variation ≤ 1.00 is 178 (89.00%) and Mean absolute variation > 1.00 is 22 (11%).

DISCUSSION

This study is the first cross-sectional study to use the Bausch and Lomb keratometer to estimate the variation of keratometric value in pre and post of SICS and its determinants between 40-80 years old patients. Since few Studies have been done in the country to estimate keratometry and there are no similar studies in this age group, comparisons could not be drawn with data from within the country. However, considering the role of age in the distribution of keratometry and the different studies conducted on various age groups, drawing comparisons with results from international studies has certain restrictions.

It is evident from our study, which evaluates the distribution of keratometry in a population based pre and post of cat sx (SICS) and its relation to age and gender, that there is fair amount of pre-existing corneal astigmatism in the population which needs correction. In this study I found the corneal astigmatism or absolute variation value in K1 are $\leq 1.00D$ in 93% and $> 1.00D$ in 8%. And absolute variation value in K2 is $< 1.00D$ 89% and $> 1.00D$ 11%. Khan et al observed corneal astigmatism to be 0.50 or less in 301 eyes (24.47%), 1.5D or less in 978 eyes (79.50%), and 3.00D or more in 24 eyes (1.93%).⁹ Ferrer Blasco et al observed that in most of the patients corneal astigmatism are less than 1D.¹⁰ Leffler et al found 1.00D pre-existing corneal astigmatism observed in their series of 161 patients.¹¹

A study conducted in German involving 23,239 eyes also showed comparatively lower rates of significant pre-

operative corneal astigmatism with only 33% of Patients having astigmatism >1.00 .¹² Shen et al observed mean preoperative corneal Astigmatism to be 2.77 ± 0.74 D.¹³ In our study we found that 516 patients (51.76%) had the Astigmatism <1 D, in 462 patients (46.34%), it are between 1D and 2D while it are more than 2D in 19 patients (1.90%), which concurs with above studies. In our study, the change in K reading are in males 38% and females 62% >50 years age group. On the other hand the K reading are decreased to 35% in males in <50 years age group and increase to 65% in females in <50 years age group. As the age advances the astigmatism becomes more common which is more evident in females as compared to males, this can be attributed to age related changes in the corneal Curvature which is mainly due to decrease in the eyelid pressure due to weakness of the eye Muscles in old age. This has been confirmed in a study conducted by Read et al.¹⁴ So during cataract surgery the incision should be placed superiorly at 12 o'clock position in younger patients, as WTR astigmatism is more common in these patients. While in older patients ATR astigmatism is more common, so the incision should be marked on temporal Side. Elinborg Gudmundsdottir and other researchers who tried to find the influence of gender on astigmatism also found the relevant findings that astigmatism has gender-related distribution in the subjects.¹⁴⁻¹⁶ In a study conducted in Iran males are found to be more Astigmatic than females in the sample.¹⁷ While in our study, we found that astigmatism are More common in females. So, it is important to analyse the prevalence and magnitude of pre-existing corneal astigmatism in patients to undergo cataract surgery, for better postoperative visual outcome.

CONCLUSION

In this cross-sectional study, we evaluated the distribution of keratometry in cataract patients to know the variation in pre and post of small incision cataract surgery (SICS) and its annual growth rate from 200 patients. Although there are an association of age and sex along with the value of k1 and k2 annual growth of astigmatic patients and induced astigmatism are associated with keratometry readings of pre and post op cataract surgery. The risk factors for induced astigmatism, as the age advances the astigmatism becomes more common which is more evident in females as compared to males. So, prevention of astigmatism, this can be easily corrected with appropriate measures like corneal relaxing incisions, excimer laser refractive procedures, femto laser assisted astigmatic keratectomy and toric IOL implantation. May be the best approach to reduce the prevalence of induced astigmatism and its complications in the future.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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