Corneal Astigmatism in Cataract

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ABSTRACT

Objective: To measure preoperative corneal astigmatism in cataract patients.
Study Design: Descriptive study.
Place and Duration of the Study: Mughal Eye Hospital, Lahore, from 2018 to 2022.
Methodology: The amount of preoperative corneal astigmatism was noted in cataract patients. Inclusion criteria included cataract patients above 16 years of age. Exclusion criteria included any preexisting corneal pathology (including corneal scar, corneal oedema, pterygium, etc.) and any previous ocular surgery, e.g. trabeculectomy, pterygium excision. SPSS version 25 was used for recording the data.
Results: Descriptive statistics were determined for demographic data and keratometry variables. Range of corneal astigmatism was zero to 5.75 dioptre with a mean of 1.05 dioptre (D) and standard deviation of 0.83. Corneal astigmatism of one or less than one diopter was recorded in 468 eyes (66.7%). Corneal astigmatism of 1.1 to 2 D was noted in 166 eyes (23.6%). Forty-nine eyes (7%) had corneal astigmatism of 2.1 to 3.0 D. Corneal astigmatism of 3.1 to 4.0 D, 4.1 to 5.0 D and 5.1 to 6 D was encountered in 11 (1.6%), 5 (0.7%) and 3 (0.4%) eyes respectively.
Conclusion: A marked proportion of patients undergoing cataract operation have corneal astigmatism, so the phacoemulsification surgeon should consider difference of keratometry findings preoperatively.

Key Words: *Corneal curvature, Corneal astigmatism, Phacoemulsification, Incision, Keratometry.*

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INTRODUCTION

Residual astigmatism after cataract surgery is one of the major causes of decreased vision after a successful phacoemulsification operation. Preoperatively assessing corneal astigmatism and planning to address it during the cataract surgery improves the visual outcome. With an increasing popularity of multifocal/trifocal lenses, perfect emmetropia can be achieved after lens surgery. Yet, another consideration is clear lens extraction or refractive lens exchange followed by multi/tri-focal lenses in presbyopia correcting surgery to achieve spectacle-free vision. This spectacle independence requires full neutralisation of spherical as well as cylindrical error after lens extraction.

A knowledge of patients' preoperative corneal astigmatism is necessary to plan appropriate measures during the lens surgery. Corneal astigmatism can be corrected by various methods which include incision at steep axis, toric intraocular lenses, limbal relaxing incisions (LRI), photorefractive keratotomy (PRK) and laser *in situ* keratomilusis (LASIK). An acuate keratometry incision can be made manually or with the help of femtosecond laser.

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In one study, 32.5% patients reporting for cataract surgery had corneal astigmatism >1 dioptre (D) of astigmatism.[1] Mean astigmatism observed was 0.9 ± 0.6 D. Sixty-eight percent had astigmatism <1 D, and 2.7% had no astigmatism. In another study, the mean corneal astigmatism noted was 0.89 D. Corneal astigmatism was <1.3 D in 80% of eyes. Astigmatism was with-the-rule (WTR) in 47% of eyes, against-the-rule (ATR) in 34%, and oblique in 20%.[2] Corneal astigmatism can be neutralised with incision at steep axis if the astigmatism is less than 1 D but if astigmatism is more, it requires toric intraocular lens or LRI. In another study, changes due to ATR shift of corneal astigmatism in the eyes having ATR astigmatism (while no change was seen in eyes having WTR astigmatism) indicated that ATR astigmatism need more correction.[3] Combining LRI with cataract incision to neutralise corneal astigmatism is very useful in achieving spectacle independence after the operation.[4] The aim of the study was to assess preoperative corneal astigmatism in patients undergoing lens extraction to achieve spectacle independence.

METHODOLOGY

It was a descriptive, cross-sectional study. Cataract patients reporting in Mughal Eye Hospital, Lahore for surgery from 2018 to 2022 were included in the study. Keratometry readings (K1 & K2) were noted with autorefractor keratometer as these were stored in the ultrasound machine which calculates the required intraocular lens (IOL) power (biometry) by combining axial length and keratometry findings. Difference between K1 and K2 was the corneal astigmatism, calculated after entering the data

in SPSS version 25. Amount of corneal astigmatism was noted preoperatively in patients who later had phacoemulsification. The inclusion criteria was cataract patients above the age of sixteen years. The exclusion criteria was any preexisting corneal pathology (including corneal scar, corneal oedema, pterygium, etc.) and any previous ocular surgery, e.g. trabeculectomy, pterygium excision. SPSS version 25 was used for recording the data (personal/demographic including name, age, sex, right/left and date of operation). Difference of keratometry readings (K1 and K2) revealed corneal astigmatism.

RESULTS

Data were collected of 752 eyes. Out of 752 eyes, 50 were excluded from the study due to missing data. Finally, 702 eyes were included in the study. Mean age was 63 years, ranging from 16 – 105. Range of corneal astigmatism was zero to 5.75 D with a mean of 1.05 D and standard deviation of 0.83. Corneal astigmatism of one or less than one diopter was recorded in 468 (66.7%) eyes. Corneal astigmatism of 1.1 to 2 D was noted in 166 (23.6%) eyes. Forty-nine (7%) eyes had corneal astigmatism of 2.1 to 3.0 D. Corneal astigmatism of 3.1 to 4.0 D, 4.1 to 5.0 and 5.1 to 6 D was encountered in 11 (1.6%), 5 (0.7%) and 3 (0.4%) eyes, respectively (Figure 1).

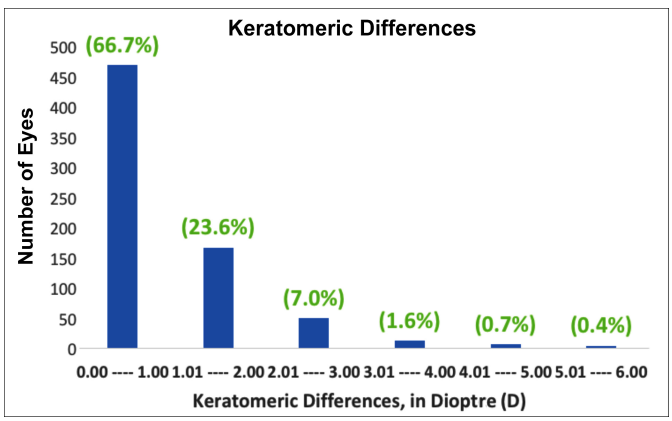

Figure 1: Distribution of corneal astigmatism in cataract patients.

DISCUSSION

The mean corneal astigmatism (1.0 D) determined in the study is very close to other study (0.9 D) mentioned above.[2] Similarly in these patients, 33.3% had corneal astigmatism >1 D. This figure is very close to the 32.5% figure mentioned in another study.[1] This category of the patients requires some active intervention to achieve emmetropia after the cataract operation, phaco. Unfortunately, many surgeons who are operating for phaco and implanting mono-focal lenses are concentrating only on the biometry to neutralise the spherical aspect. Their habit to consider keratometry is not established. One should calculate preexisting corneal astigmatism and one's own surgically-induced astigmatism (SIA) before starting the surgery. Thus, these surgeons are not making corneal incision at the steep axis or doing anything to correct cylindrical astigmatism. Due to this deficiency, many patients do not receive astigmation correction.

In one study, different locations (superotemporal and temporal) of the cataract incisions caused differences in the meridians of oblique astigmatism in some patients but did not have a significant effect on the amount of corneal astigmatism.[5] Some racial/demographic differences have also been noted. Against-the-rule (ATR) astigmatism was more prevalent, more in measurement, and its onset was earlier in Syrian refugees than in the Turkish individuals.[6]

One component in postoperative corneal astigmatism is SIA which should be known by all surgeons.[7] In cataract operation, the cornea flattens in the meridian of the incision. SIA in phacoemulsification with 2.8 or 3.2 mm corneal incision is very small i.e. in a range of 1/4th of a dioptre.[8] One study noted that implantable collamer lens (ICL) surgery incision does not increase corneal SIA (a factor to be considered for inexperienced surgeons).[9] In one study, smaller corneal incisions were associated with slight reduction of SIA, however, it induced more loss of endothelial cells.[10] In eyes with very low preoperative astigmatism, better uncorrected VA with1.0 D toric IOLs (as compared to spherical IOL) was due to neutralising surgically induced astigmatism as well as neutralising corneal astigmatism.[11] Reducing the incision size from 2.8 to 2.2 mm did not reduce SIA.[12]

Corneal astigmatism in candidates for cataract surgery has been observed in different studies across the globe. One study from Central China revealed that the corneal astigmatism of 0.5 -1.0 D was the most commonly found range (34.96%). Their study showed 10.6% patients with greater than 2.0 D of corneal astigmatisms, while in this study, 10% eyes had >2 D of corneal astigmatism. Against-the-rule (ATR) astigmatism was found to increase with and with-the-rule (WTR) astigmatism was found to decrease with age in 3209 eyes.[13] A study in Guangzhou, China, found mean corneal astigmatism of 1.01 (range of 0.05 to 6.6) D. Corneal astigmatism was 0.25 to 1.25 D in 68% of eyes, 1.25 D or higher in 28% eyes, and less than 0.25 D in 5% of eyes. Against-the-rule astigmatism increased significantly with older age. These figures were found after examination of 4831 eyes.[14]

In National Health Service (NHS), Northern Ireland, Cataract Surgery Practice found 41% and 11.6% of eyes had more than 1.00 D and more than 2.00 D of corneal astigmatism respectively. These figures were based on examination of 2080 eyes.[15]

In United Arab Emirates, mean corneal astigmatism was 1.3 ± 1 D and 32% had corneal astigmatism of 1.5 D or more. This analysis was based on 238 eyes.[16]

In Caucasian patients, the corneal astigmatism (mean) was 1 ± 0.7 D, the range was 0.06 - 4.6 D) and 1 D or more was present in 42% eyes. The study showed that half of the eyes had astigmatism of more than 1 D; 757 eyes were included in this analysis.[17]

Corneal astigmatism in Indian population was less than 1 D in 59%, 1.0 - 1.99 D in 29% eyes, 2 - 2.99 D in 8% eyes, and more than 3.0 D in 5% eyes. The mean was 1 ± 1 D. Over 40% of the patients who had >1.0 D of corneal astigmatism required toric IOL. This study was conducted on 2502 eyes.[18]

In Brazil, corneal astigmatism was: mean 0.9 ± 1 D (range 0 - 10.25 D), <1 D in 57% eyes, 1.0 -1.99 D in 29% eyes, 2 - 2.99 D in 9% eyes, and more than 3.0 D in 5% eyes. A total of 1707 eyes were included in this study.[19]

In Bosnia and Herzegovina, corneal astigmatism was, 1 D or more, 1.5 D or more, 2.0 D or more and 3.0 D or more in 32%, 18%, 10% and 3% of eyes, respectively. Symmetrical astigmatism was observed in both eyes of patients with astigmatism >2.5 D. This was a large study which included 4080 eyes.[20]

An analysis of these figures described in the above-mentioned studies revealed that mean astigmatism of corneal origin in patients undergoing cataract surgery around the globe was around one diopter and astigmatism of less than 1 D is present in 65 – 70%. This is the astigmatism which can be neutralised by incision manipulations, provided the surgeon has preoperative plan for it. The amount of astigmatism of more than one diopter is present in 30 – 35% if the above-mentioned studies are combined. This is the astigmatism that requires toric intraocular lens of the appropriate power, adjusted at the desired angle. This again requires preoperative management preparation and availability of the desired intraocular lens. The lesson to be learnt is that it is high time that cataract surgeons make it a habit to consider the keratometric findings and make necessary arrangements before starting the operation.

The strength of this study was the modestly large number of eyes (more than 700) included in the analysis for keratometric findings. The main limitation of this study was that it measured only preoperative corneal astigmatism and the retrospective nature of the study. Postoperative astigmatism has measured, the authors would have been able to calculate SIA also.

CONCLUSION

Surgeons should consider difference of keratometry findings preoperatively. As a significant proportion of patients undergoing cataract operation have corneal astigmatism, treating surgeon should make a plan to neutralise it before starting the operation.

ETHICAL APPROVAL:
IRB approval was taken from Ophthalmological Society of Pakistan (OSP-IRB003/2023 dated 31-01-2023).

PATIENTS' CONSENT:
Informed, written consents were taken before biometry of cataract patients.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
KKS: Planned the study, reviewed the literature, collected the data, written, edited, and reviewed the study.
TS: Collected the data, written, edited, reviewed, and approved the study.
All authors approved the work for publication.

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