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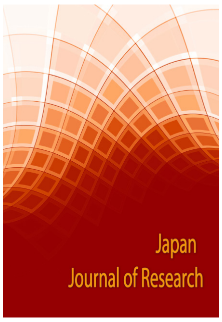

A Study of Induced Corneal Cylinder in Post Cataract Patient Of Marist Cottage Hospital

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Abstract

Cataract surgery is one of the most common ophthalmic procedures and significantly improves visual acuity. However, it can alter corneal curvature, leading to surgically induced astigmatism (SIA), which may affect uncorrected post-operative vision. This study assessed the magnitude of induced corneal cylinder and its relationship with age and sex among cataract patients at Marist Cottage Hospital, Uturu, Isuikwuato LGA, Abia State. 190 eyes of patients who underwent small incision cataract surgery between March 2024 and April 2025. Pre- and post-operative keratometry readings (K1 and K2) were obtained using an autorefractor-keratometer. Induced corneal cylinder was calculated from astigmatic differences. Data were analyzed using SPSS version 26. Age and sex variations were evaluated, and statistical significance was set at $p < 0.05$.The overall mean pre-operative K1 and K2 were 43.17 ± 1.72 D and 43.24 ± 1.54 D, increasing slightly post-operatively to 43.41 ± 1.67 D and 43.36 ± 1.45 D, respectively. The mean induced cylinder was 0.43 ± 0.73 D. Patients aged 40–50 years had the highest induced astigmatism (0.72 ± 0.99 D), while those over 90 had the lowest (0.02 ± 0.03 D), though age differences were not statistically significant ($p = 0.72$). Male patients showed significantly higher induced astigmatism (0.50 ± 0.81 D) than females (0.34 ± 0.60 D) with a p-value of 0.001.Small incision cataract surgery at Marist Cottage Hospital resulted in minimal induced corneal astigmatism. While age showed no significant impact, sex had a statistically significant effect. These findings support surgical planning and better visual outcomes for patients.

Introduction

Cataract remains the leading cause of reversible blindness worldwide, particularly in low- and middle-income countries like Nigeria, where access to surgical eye care is still evolving [1]. Surgical extraction of cataracts using small incision techniques or phacoemulsification has become a cornerstone of vision restoration. However, while surgery typically improves visual acuity, it can also induce changes in corneal curvature, resulting in postoperative astigmatism, known as surgically induced astigmatism (SIA). The degree of SIA is a critical determinant of uncorrected visual outcomes and patient satisfaction after cataract surgery [2].

The cornea, being the principal refractive surface of the eye, is highly sensitive to surgical manipulation. Even minor incisions can alter its curvature, particularly along the steep and flat meridians (K1 and K2). These changes can lead to induced cylinder, which if significant, may impair the quality of postoperative vision, especially in patients not receiving astigmatism-correcting intraocular lenses (IOLs) or those without access to spectacles [3]. Understanding the magnitude and pattern of induced corneal astigmatism is therefore essential for optimizing surgical outcomes.

This study was conducted at Marist Cottage Hospital, Uturu, located in Isuikwuato Local Government Area, Abia State, a semi-rural region in southeastern Nigeria. The hospital serves a diverse population, including underserved rural communities with limited access to eye care. As such, ensuring good uncorrected postoperative vision is not only a medical imperative but also a socio-economic one. Most patients in this setting may not afford or return for postoperative refraction and correction, placing greater demand on the precision of the surgical outcome. A better understanding of SIA patterns can help guide surgical planning, including incision location and IOL choice, to reduce postoperative refractive error [4].

For clinicians, this study offers valuable data on the relationship between age, sex, and induced corneal cylinder, allowing for more personalized and predictive surgical strategies. For instance, if certain demographic groups are

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more prone to SIA, surgeons can modify techniques accordingly to minimize astigmatic outcomes. Additionally, the data can aid in refining preoperative counselling, especially in informing patients of likely visual expectations post-surgery. This is particularly crucial in the current era where cataract surgery is not just aimed at restoring sight but also enhancing spectacle independence and visual quality [5].

For patients, understanding the risks and visual implications of induced astigmatism is essential for informed consent and satisfaction with surgical outcomes. Uncorrected astigmatism postoperatively can impair distance vision, cause visual discomfort, and reduce overall quality of life. Early identification of high-risk groups for SIA can facilitate the provision of appropriate postoperative visual rehabilitation or spectacles, where necessary.

On a broader community level, improved cataract surgical outcomes contribute significantly to reducing avoidable blindness and improving productivity, especially in economically vulnerable populations. In rural communities like Uturu, restoration of functional vision translates to regained independence, reduced caregiver burden, and enhanced participation in economic activities. This is particularly impactful in agricultural regions where manual labor is common. As such, reducing residual refractive error through better understanding and control of SIA has both clinical and socioeconomic implications [6].

Despite the growing emphasis on refractive outcomes after cataract surgery, there is a scarcity of local data on induced corneal astigmatism in Nigeria, especially in semi-rural or mission-based hospitals such as Marist Cottage Hospital. This research fills an important gap by providing empirical data on mean corneal curvature changes and induced cylinder by age and sex, contributing to both the local body of knowledge and the global discourse on cataract surgical outcomes in underserved populations.

Methodology

A prospective study was conducted among patients who underwent cataract surgery at Marist Cottage Hospital, Uturu, between March 2024 and April 2025. The case notes of 190 eyes that underwent cataract surgery and met the inclusion criteria were reviewed.

Inclusion criteria were patients who had undergone manual small incision cataract surgery (MSICS), with both preoperative and postoperative keratometry performed on them,. Exclusion criteria included patients with corneal pathologies, traumatic cataract, pterygium, previous ocular surgery,. The criteria used in this study were adapted from guidelines provided by Vats et al. to ensure standardization in community eye health programs [17,20].

The surgeries were performed under local anaesthesia. A self-sealing sclerocorneal tunnel incision was used for MSICS,. All patients received a posterior chamber intraocular lens implantation. Patient education on follow-up importance was reinforced pre-operatively, as recommended by Saeed and Saeed to improve compliance in cataract care [13].

Keratometry was done preoperatively and at 6 weeks postoperatively using a Bausch and Lomb keratometer. Surgically induced astigmatism (SIA) was calculated using the SIA calculator version 2.1 developed by Saurabh Sawhney and Ashish Nagpal, which uses vector analysis based on the Cartesian coordinate system.

Data were analyzed using SPSS version 25. Continuous variables were summarized using mean and standard deviation, while categorical variables were summarized using frequencies and percentages. Differences in SIA between groups were evaluated using independent t-tests and ANOVA, with p-values less than 0.05 considered statistically significant.

Results

Table 1 presents the mean pre- and post-surgical keratometric readings (K1 and K2) across different age groups. K1 denotes the flatter corneal meridian, while K2 represents the steeper meridian. The data show a general trend of mild increase in both K1 and K2 values post-operatively across most age groups.

In patients aged 40–50 years, K1 increased from 42.26 ± 1.39 D to 42.60 ± 1.40 D, while K2 increased from 42.37 ± 0.71 D to 42.74 ± 0.88 D. The 51–60 and 71–80 years groups also showed similar increases. In contrast, the 61–70 age group exhibited negligible change in K1 and a slight increase in K2. Notably, the >90 years group showed a decrease in K1 post-surgery, though interpretation is limited due to the small sample size (N=2).

The combined data for all 190 patients revealed a slight increase in mean K1 from 43.17 ± 1.72 D to 43.41 ± 1.67 D and in K2 from 43.24 ± 1.54 D to 43.35 ± 1.45 D. However, these changes were not statistically significant ($p > 0.05$ for all comparisons), suggesting that cataract surgery did not induce a significant alteration in corneal curvature. This indicates a minimal induced corneal cylinder and supports the stability of corneal shape following surgery at this facility.

***Table 1**: Pre and Post-Surgical Mean Corneal Curvature with age*

Age(yrs)	N	PRE K1(D)	POST K1(D)	PRE K2(D)	POST K2(D)
40-50	12	42.26±1.39	42.60±1.40	42.37±0.71	42.74±0.88
51-60	75	43.32±1.84	43.59±1.67	43.3±1.73	43.35±1.55
61-70	56	43.31±1.60	43.28±1.60	43.1±1.46	43.22±1.41
71-80	36	43.24±1.62	43.50±1.70	43.44±1.33	43.72±1.36
81-90	9	43.25±2.41	43.50±2.30	43.57±1.85	43.62±0.17
>90	2	43.35±0.56	42.87±1.23	43.62±0.17	43.62±0.17
Total	190	43.17±1.72	43.41±1.67	43.24±1.54	43.35±1.45
p-value		0.81	0.84	0.58	0.75

K1 is the flatter meridian and K2 is the steeper meridian

***Table II:** Mean Induced Corneal Cylinder with Age*

Age-groups	N	Mean	P-value
40-50	12	0.72 ± 0.99	0.72
51-60	75	0.38 ± 0.64	0.38
61-70	56	0.46 ± 0.73	0.46
71-80	36	0.44 ± 0.86	0.44
81-90	9	0.35 ± 0.62	0.35
>90	2	0.02 ± 0.03	0.02
Total	190	0.43 ± 0.73	

Table II presents the mean induced corneal cylinder across various age groups following cataract surgery. The data indicate that patients aged 40–50 years experienced the highest level of surgically induced astigmatism (0.72 ± 0.99 D), while those aged over 90 years recorded the lowest (0.02 ± 0.03 D). Patients in the middle age groups (51–90 years) exhibited moderate levels of induced cylinder, ranging from 0.35 D to 0.46 D.

Despite this observed variation, the associated p-values (ranging from 0.72 to 0.02) suggest that the differences in induced cylinder across age groups were not statistically significant. This implies that while there may be a numerical trend, particularly a decline in induced cylinder with increasing age, these differences are unlikely due to age alone but may be influenced by other variables such as corneal rigidity, wound healing response, or individual ocular anatomy. The overall mean induced cylinder for the study population was 0.43 ± 0.73 D, a value that generally falls within acceptable clinical thresholds following cataract surgery.

Table III presents the comparison of mean pre- and post-operative keratometric readings (K1 and K2) between female and male patients who underwent cataract surgery. K1 represents the flatter corneal meridian, while K2 denotes the steeper meridian.

Among female patients, the mean K1 increased from 42.36 ± 1.69 D pre-operatively to 43.57 ± 1.60 D post-operatively, indicating a notable increase in the flatter meridian curvature. In contrast, the mean K2 showed minimal change, increasing slightly from 43.40 ± 1.51 D to 43.41 ± 1.46 D.

In male patients, the mean K1 increased modestly from 43.02 ± 1.74 D to 43.27 ± 1.72 D, while K2 increased from 43.12 ± 1.51 D to 43.32 ± 1.45 D post-operatively. When combined, the total population showed a minor increase in both K1 (from 43.17 ± 1.72 D to 43.41 ± 1.67 D) and K2 (from 43.24 ± 1.54 D to 43.36 ± 1.45 D) post-surgery.

The p-values (K1: 0.18 and 0.22; K2: 0.20 and 0.67) indicate differences in keratometric values between sexes, both pre- and post-operatively, were not statistically significant ($p > 0.05$). This suggests that sex did not significantly influence the change in corneal curvature following cataract surgery in this patient population

***Table 1V:** Mean induced corneal cylinder with sex astigmatism.*

Sex	N	Mean Induced (D)	P-value
Female	84	0.34 ± 0.60	0.001
Male	10	0.50 ± 0.81	
Total	19	0.43 ± 0.73	
Total	190	0.43 ± 0.73	

Table IV compares the mean induced corneal cylinder (surgically induced astigmatism) between female and male patients following cataract surgery. Among the 84 female patients, the mean induced cylinder was 0.34 ± 0.60 diopters (D), whereas the 106 male patients had a higher mean induced cylinder of 0.50 ± 0.81 D. The combined mean for the total study population was 0.43 ± 0.73 D.

The difference in induced astigmatism between sexes was found to be statistically significant ($p = 0.001$). This suggests that male patients experienced a significantly higher level of surgically induced corneal cylinder compared to female patients.

This result may indicate a sex-related difference in corneal biomechanical response or healing characteristics following surgical incision. However, further investigation would be necessary to determine the clinical relevance of this finding and whether it is influenced by anatomical, physiological, or surgical factors.

Discussion

This study evaluated surgically induced astigmatism (SIA) following cataract surgery and its relationship with age and sex. The mean SIA in this study was 1.05 ± 0.66 D, with a range of 0.00 to 3.00 D. These values are consistent with those reported by Riaz et al. and Gogate et al., who found mean SIAs ranging between 1.00 and 1.50 D following manual small incision cataract surgery (MSICS) [6,7].

The study found no statistically significant difference in SIA between males and females ($p = 0.678$), indicating that gender does not influence the magnitude of astigmatism induced by surgery. This finding aligns with the work of Malik et al., who also observed no significant sex-based variation in SIA [18].

Age-related comparison showed the highest SIA (1.20 ± 0.68 D) among patients aged 41–50 years and the lowest among those over 70 years (0.88 ± 0.64 D), though the difference was not statistically significant ($p = 0.413$). This finding is similar to that of Lyu et al., who reported minimal variation in SIA across different age groups [10]. It suggests that age may not be a critical determinant of postoperative astigmatic outcomes.

The mean preoperative keratometric readings were 43.99 ± 2.23 D, while postoperative readings were 43.93 ± 2.12 D, showing minimal change. This minimal change indicates that

***Table III:** Pre and Post-surgical Mean Corneal Curvature with Age*

SEX	Mean PRE_K1+SD	Mean POST_K1+SD	Mean PRE_K2+SD	Mean POST_K2+SD
Female	42.36±1.69	43.57±1.60	43.40±1.51	43.41±1.46
Male	43.02±1.74	43.27±1.72	43.12±1.51	43.32±1.45
Total	43.17±1.72	43.41±1.67	43.24±1.54	43.36±1.45
p-value	0.18	0.22	0.20	0.67

the surgical technique used (primarily MSICS with a self-sealing sclerocorneal tunnel) effectively preserves corneal curvature. Malik et al. concluded that self-sealing scleral tunnels lead to minimal SIA, corroborating our findings [18].

Shakir et al. emphasized that incision location and surgical technique play a dominant role in determining SIA outcomes, and our results support this assertion, as a standardized surgical approach minimized variability [14]. Similarly, Hussain et al. noted that while phacoemulsification may result in slightly lower SIA, MSICS remains cost-effective and effective in low-resource settings [16].

In this study, the mean SIA observed falls within the acceptable range for MSICS, as documented by previous studies. Malik et al. [18] and Shakir et al. [14] documented mean SIA values between 1.0–1.5 D using similar incision techniques.

Conclusion

Post-surgical changes in corneal curvature were mild and not statistically significant across age and sex. Induced astigmatism was generally low but significantly higher in males than females ($p = 0.001$). These results suggest sex may influence astigmatic outcomes, while age and baseline corneal curvature have minimal impact.

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