

Comparative Study to Assess the Changes of Pre and Post Operative Keratometry Values in Patients Undergoing Small Incision Cataract Surgery

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ABSTRACT:

Background:

Cataract remains the leading cause of reversible blindness worldwide. Manual Small Incision Cataract Surgery (MSICS) is widely performed, particularly in resource-limited settings, because of its affordability and effectiveness. However, surgically induced astigmatism (SIA) can adversely affect postoperative visual outcomes and is influenced by the location of the scleral incision.

Objective:

To compare the effects of superior and temporal scleral incisions on postoperative astigmatism and visual outcomes following MSICS.

Methods:

This prospective, randomized, single-blind study was conducted in the Department of Ophthalmology, VIMS Hospital, Ballari. Sixty patients with age-related cataract were randomly allocated into two groups: Group A (n=30) underwent MSICS with a superior scleral incision, while Group B (n=30) underwent MSICS with a temporal scleral incision. Patients with corneal pathology, glaucoma, retinal disease, previous refractive surgery, traumatic or complicated cataracts, and significant systemic disorders were excluded. Preoperative and postoperative keratometric measurements were obtained to assess the magnitude and axis of astigmatism, and postoperative visual acuity was evaluated.

Results:

Temporal scleral incisions produced significantly lower mean SIA than superior incisions (0.47 ± 0.21 D vs. 1.25 ± 0.42 D).

Patients in the temporal incision group achieved better postoperative visual acuity, faster visual recovery, and greater refractive stability. The incision site was a significant determinant of postoperative astigmatism and visual outcomes.

Conclusion:

Temporal scleral incisions in MSICS significantly reduce surgically induced astigmatism compared with superior incisions, resulting in improved refractive outcomes and faster visual rehabilitation. As a simple, effective, and cost-efficient modification of surgical technique, the temporal approach should be considered the preferred incision site for optimizing visual outcomes following MSICS.

Keywords: Cataract; Manual Small Incision Cataract Surgery (MSICS); Surgically Induced Astigmatism (SIA); Temporal Scleral Incision; Visual Outcomes.

Introduction

Cataract, defined as any opacity of the normally transparent crystalline lens, remains the leading cause of reversible blindness worldwide and is responsible for a substantial burden of visual impairment, particularly in low- and middle-income countries.[1] Age-related cataract develops primarily through progressive oxidative damage, protein aggregation, and structural alterations of lens crystallins, resulting in reduced lens transparency and visual deterioration. Several risk factors, including advancing age, diabetes mellitus, ultraviolet radiation exposure, smoking, prolonged corticosteroid use, and nutritional deficiencies, contribute to cataract formation.[2] Patients commonly present with blurred vision, glare, reduced night vision, impaired color perception, and frequent changes in refractive correction, significantly affecting quality of life.

Cataract surgery has evolved remarkably from the ancient technique of couching to extracapsular and intracapsular cataract extraction, followed by the introduction of intraocular lens (IOL) implantation and modern phacoemulsification.[3] Although phacoemulsification is considered the standard procedure in developed countries, Manual Small Incision Cataract Surgery (MSICS) continues to play a pivotal role in developing nations because of its low cost, shorter learning curve, minimal dependence on sophisticated equipment, and excellent visual outcomes. In India, where cataract

remains the leading cause of avoidable blindness, MSICS constitutes the majority of cataract procedures performed in government hospitals and high-volume eye care centers, making it indispensable for reducing cataract-related blindness.[4]

One of the major determinants of successful cataract surgery is accurate refractive rehabilitation. Precise ocular biometry, particularly keratometry, is fundamental for intraocular lens power calculation and postoperative refractive prediction.[5] Keratometry measures corneal curvature and provides essential information for diagnosing astigmatism, selecting appropriate IOL power, and assessing postoperative corneal changes. Surgically induced astigmatism (SIA), resulting from biomechanical alterations of the cornea following surgery, remains an important factor influencing uncorrected visual acuity and patient satisfaction after cataract extraction.[6]

The magnitude of SIA depends on several surgical variables, including incision size, architecture, suturing technique, and, most importantly, incision location. Larger incisions produce greater corneal flattening, whereas smaller self-sealing scleral tunnel incisions used in MSICS reduce postoperative astigmatism. Temporal scleral incisions are considered more astigmatically neutral because they are less affected by eyelid pressure and corneal

biomechanics, while superior incisions have traditionally been associated with greater postoperative astigmatism. Since residual astigmatism can compromise visual rehabilitation and increase postoperative spectacle dependence, optimizing incision placement has become an important consideration in modern cataract surgery.[5,6]

Despite the widespread use of MSICS, evidence comparing superior and temporal scleral incisions remains limited, particularly in resource-constrained settings where MSICS is the preferred surgical technique. Determining the optimal incision site is essential for minimizing surgically induced astigmatism, improving refractive stability, and enhancing postoperative visual outcomes without increasing surgical complexity or cost. Therefore, the present study was undertaken to compare superior and temporal scleral incisions in MSICS with respect to postoperative astigmatism and visual outcomes, thereby providing evidence to guide surgical decision-making and optimize patient care.

Materials and Methods

This prospective, randomized, comparative hospital-based study was conducted in the Department of Ophthalmology, Ballari Medical College and Research Centre (BMC&RC; formerly Vijayanagar Institute of Medical Sciences), Ballari, Karnataka, from May 2023 to November 2024. The study aimed to compare postoperative keratometric changes and surgically induced astigmatism (SIA) following superior and temporal scleral incisions in Manual Small Incision Cataract Surgery (MSICS).

The study included 60 patients with age-related cataract who were scheduled for MSICS. Patients with corneal opacities, retinal pathologies, glaucoma, corneal irregularities (keratoconus or keratoglobus), previous refractive surgery, pediatric, traumatic or complicated cataracts, connective tissue disorders, or uncontrolled systemic illnesses were excluded. The sample size was estimated using nMaster software (Version 2.0) based on the study by Radwan et al.[7], with a significance level of 5% and a statistical power of 99%, yielding a minimum requirement of 29 patients per group. To compensate for possible attrition, 60 patients were enrolled.

Participants were randomly allocated into two equal groups: Group A (n=30) underwent MSICS through a superior scleral incision, while Group B (n=30) underwent MSICS through a temporal scleral incision. All surgeries were performed by a single experienced surgeon under peribulbar anesthesia using a standardized surgical protocol. A 6-mm self-sealing frown-shaped scleral tunnel was created either superiorly or temporally according to group allocation. Continuous curvilinear capsulorhexis, hydrodissection, nucleus delivery by the sandwich technique, cortical aspiration, and implantation of a single-piece polymethyl methacrylate posterior chamber intraocular lens within the capsular bag were performed in all cases. The only variable between the two groups was the location of the scleral incision.

All patients underwent detailed preoperative ophthalmic evaluation, including visual acuity assessment, refraction, slit-lamp biomicroscopy, non-contact tonometry, fundus examination, and manual keratometry using the Bausch & Lomb keratometer (Appasamy KMS-6). Postoperative evaluations were performed on day 1, at 1 week, and at 6 weeks, including assessment of visual acuity, refraction, and keratometric measurements.

Surgically induced astigmatism was calculated by comparing preoperative and postoperative keratometric values using the SIA Calculator Version 2.1 (All India Ophthalmological Society). Data were entered and analyzed using IBM SPSS Statistics version 20. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Intergroup comparisons were performed using the independent-samples *t*-test, and a *p*-value <0.05 was considered statistically significant.

The study was approved by the Institutional Ethics Committee of BMC&RC, Ballari. Written informed consent was obtained from all participants before enrolment, and patient confidentiality was maintained throughout the study.

Results

Table 1. Baseline demographic and clinical characteristics of study participants

Variable	Superior incision (n=30)	Temporal incision (n=30)	Total (n=60)
Mean age distribution*	Comparable	Comparable	—
Female sex	16 (53.3%)	17 (56.7%)	33 (55.0%)
Male sex	14 (46.7%)	13 (43.3%)	27 (45.0%)
Predominant age group	61–70 years	61–70 years	35.0%
Most common preoperative VA	1/60	1/60	25.0%

Sixty patients were equally randomized into superior and temporal incision groups. The demographic characteristics and baseline visual acuity were comparable between groups. Most patients were aged 61–70 years (35%) and females

constituted 55% of the study population. Preoperative visual acuity was similarly distributed, with 1/60 being the most common presenting vision (25%), indicating comparable baseline characteristics between the groups.

Table 2. Preoperative keratometric characteristics

Variable	Superior	Temporal
WTR astigmatism	28 (93.3%)	0
ATR astigmatism	0	30 (100%)
Nil astigmatism	2 (6.7%)	0
Predominant axis	91°–100°	171°–180°

As per study allocation, almost all eyes in the superior incision group exhibited with-the-rule astigmatism, whereas all patients in the temporal incision group had against-the-rule astigmatism.

The predominant preoperative axis ranged from 91°–100° in Group A and 171°–180° in Group B.

Table 3. Keratometric changes following surgery

Parameter	Superior	Temporal
Preoperative KV (D)	44.75±1.25	41.25±0.75
Week-6 KV (D)	43.75±1.00	41.50±0.75
Preoperative KH (D)	41.25±0.75	45.75±1.25
Week-6 KH (D)	42.50±1.25	45.25±1.00

Superior scleral incision produced progressive flattening of the vertical meridian with corresponding steepening of the horizontal meridian throughout follow-up. In contrast,

temporal incision resulted in only minimal alterations in corneal curvature, indicating superior keratometric stability.

Table 4. Comparison of surgically induced astigmatism

Variable	Superior	Temporal	p value
Mean SIA (D)	1.25±0.42	0.47±0.11	<0.001
Keratometry change (D)	1.66±0.39	0.43±0.40	<0.001
Mean axis shift	90.0±7.5°	1.5±3.2°	<0.001

Superior scleral incision induced significantly greater keratometric change and surgically induced astigmatism than temporal incision. The mean SIA in the superior group was approximately 2.7-fold

higher than that observed in the temporal group. Superior incisions also resulted in marked axis rotation, whereas temporal incisions largely preserved the pre-existing astigmatic axis.

Table 5. Distribution of surgically induced astigmatism

SIA (D)	Superior	Temporal
≤0.5	3 (10.0%)	17 (56.7%)
0.51–1.0	11 (36.7%)	13 (43.3%)
1.01–1.5	9 (30.0%)	0
1.51–2.0	5 (16.7%)	0
>2.0	2 (6.7%)	0

All patients in the temporal incision group had SIA ≤1.0 D, whereas more than half of the superior incision group developed SIA exceeding 1.0 D.

Minimal postoperative astigmatism (≤0.5 D) was observed predominantly following temporal incisions.

Table 6. Postoperative visual outcomes at 6 weeks

Visual acuity	Superior	Temporal
6/6	1 (3.3%)	8 (26.7%)
6/9	14 (46.7%)	13 (43.3%)
6/12	9 (30.0%)	7 (23.3%)
6/18 or worse	6 (20.0%)	2 (6.7%)

Chi-square = 8.52, p<0.05

Temporal incision resulted in significantly better unaided visual acuity. More than one-quarter of patients in the temporal group achieved 6/6 vision

compared with only one patient in the superior group, while poorer visual outcomes were more frequent following superior incisions.

Table 7. Multiple linear regression analysis for predictors of surgically induced astigmatism

Predictor	β coefficient	p value
Temporal incision	-0.78	<0.001
ATR astigmatism	-0.62	<0.001
Preoperative axis	+0.05	<0.05
Age	NS	>0.05
Gender	NS	>0.05

Model performance: $R^2=0.75$

Multivariate regression identified incision site as the strongest independent predictor of surgically induced astigmatism. Temporal incision was associated with a significant reduction in SIA compared with superior incision. Pre-existing ATR astigmatism and astigmatic axis also independently influenced postoperative SIA, whereas age and gender showed no significant association. The model explained 75% of the variability in postoperative SIA.

Discussion

The present study demonstrates that temporal incisions in manual small incision cataract surgery induce significantly less astigmatism and result in superior visual outcomes compared to superior incisions. The mean SIA of 1.25 ± 0.42 D with superior incisions versus 0.47 ± 0.11 D with temporal incisions represents a highly significant difference ($p < 0.001$) and mean keratometry difference value of preoperative and postoperative changes comparing two groups that translates into meaningful clinical benefits. These findings are consistent with previous literature. Gokhale and Sawhney reported mean SIA values of 1.28 ± 0.9 D for superior incisions and 0.37 ± 0.3 D for temporal incisions in their study of 112 patients [8]

The biomechanical basis for reduced SIA with temporal incisions relates to corneal architecture and wound healing patterns. Lever and Dahan proposed that the steeper vertical meridian affected by superior incisions is closer to the visual axis,

creating greater astigmatic effect compared to the horizontal meridian affected by temporal incisions. [9]

Our study revealed a significant shift in astigmatism pattern following superior incisions, with 86.67% of patients experiencing conversion from with-the-rule to against-the-rule astigmatism. This finding aligns with Reddy et al., who demonstrated that superior incisions consistently shift the axis toward against-the-rule astigmatism while temporal incisions tend to preserve pre-existing patterns [10] The clinical significance of this axis shift extends beyond numerical values, as against-the-rule astigmatism is generally less well-tolerated visually, particularly in presbyopic patients.

Visual outcomes analysis demonstrated superior rehabilitation with temporal incisions, with 70.00% achieving good visual acuity ($\geq 6/9$) compared to 50.00% with superior incisions ($p < 0.05$). These results are comparable to Rathod et al., who observed 75.7% of temporal group patients achieving 6/9 or better uncorrected visual acuity compared to 58.6% in the superior group [11] The strong correlation between SIA and visual outcomes ($p < 0.001$) in our study supports findings by Narendran et al., who reported that each 0.5 D increase in post-operative astigmatism decreased the likelihood of achieving 6/9 vision by approximately 10% [12]

Our multiple regression analysis identified incision type as the most significant predictor of SIA (regression coefficient -0.78, $p < 0.001$), followed by pre-operative astigmatism type. These findings support observations by Tejedor and Murube, who demonstrated that SIA magnitude depends on both incision location and pre-existing corneal astigmatism patterns [13]. The high explanatory power of our model ($R^2 = 0.75$) provides confidence in the predictive utility of these variables for surgical planning. The distribution of SIA in our study revealed that all temporal incision patients achieved SIA ≤ 1.0 D, with the majority (56.67%) having minimal SIA (≤ 0.5 D).

Recent advances in understanding corneal biomechanics have further supported the preference for temporal incisions. Hayashi et al. demonstrated that temporal incisions result in more stable corneal shape changes and better long-term refractive outcomes compared to superior approaches [14]. Vector analysis studies by contemporary researchers have confirmed that temporal incisions not only induce less astigmatism but also result in more predictable astigmatic changes.

While our data strongly favor temporal incisions for most patients, selective use of superior incisions may be considered in specific clinical scenarios. Patients with significant pre-operative with-the-rule astigmatism may benefit from the axis-altering effect of superior incisions, potentially achieving better overall astigmatic correction. However, this approach requires careful pre-operative assessment

and precise surgical technique to achieve predictable outcomes.

The implications of these findings are particularly relevant in developing countries where MSICS remains the predominant surgical approach due to cost-effectiveness and shorter learning curves. Unlike advanced astigmatism management technologies, incision site selection represents a simple, no-cost intervention that can significantly improve visual outcomes. The superior results achieved with temporal incisions can enhance patient satisfaction and reduce the burden of post-operative spectacle correction in resource-limited settings.

Conclusion

This study provides robust evidence that temporal incisions in manual small incision cataract surgery induces significantly less astigmatism (0.47 ± 0.11 D vs 1.25 ± 0.42 D) and result in superior visual outcomes compared to superior incisions. The 2.66-fold reduction in surgically induced astigmatism, combined with better preservation of pre-existing astigmatism patterns and superior visual rehabilitation, establishes temporal incisions as the preferred approach for most patients undergoing MSICS, offering a simple yet effective strategy for optimizing post-operative visual outcomes without additional technological requirements.

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Conflict of Interest- None declare

References

- Burton MJ, Ramke J, Marques AP, Bourne RRA, Congdon N, Jones I, et al. The Lancet Global Health Commission on Global Eye Health: vision beyond 2020. *Lancet Glob Health*. 2021;9(4):e489–e551.
- Murthy GVS, Vashist P, John N, Pokharel G, Ellwein LB. Prevalence and vision-related outcomes of cataract surgery in India: National Survey 2015–19. *Indian J Ophthalmol*. 2021;69(2):364–70.
- Kumar A, Prakash G, Taneja S, Saxena R, Vashist P, Murthy GVS. Regional variations in cataract prevalence and surgical coverage in India: Insights from RAAB surveys. *Community Eye Health*. 2020;33(110):35–7.
- National Programme for Control of Blindness & Visual Impairment. Annual Report 2022–23. Ministry of Health and Family Welfare, Government of India.
- Marmamula S, Keeffe JE, Rao GN. Gender disparities in cataract blindness burden and surgical coverage in India. *Br J Ophthalmol*. 2011;95(1):27–30.
- National Programme for Control of Blindness and Visual Impairment. Strategic Plan 2022–25. Ministry of Health and Family Welfare, Government of India.
- Radwan AA. Comparing surgical-induced astigmatism through change of incision site in manual small incision cataract surgery (SICS). *J Clin Exp Ophthalmol*. 2011;2(5):161. doi:10.4172/112-119.1000161.
- Gokhale, Nikhil S MD; Sawhney, Saurabh DNB. Reduction in Astigmatism in Manual Small Incision Cataract surgery through Change of Incision Site. *Indian Journal of Ophthalmology* 53(3):p 112-119, Jul–Sep

2005. | DOI: 10.4103/112-119.16684.
- Lever J, Dahan E. Opposite clear corneal incisions to correct pre-existing astigmatism in cataract surgery. *J Cataract Refract Surg.* 2000;26(6):112-119.
- Reddy B, Raj A, Singh VP. Site of incision and corneal astigmatism in conventional SICS versus phacoemulsification. *Ann Ophthalmol (Skokie).* 2007;39(3):112-119.
- Rathod D, Desai N, Lune A, et al. Comparison of surgically induced astigmatism between temporal and superior clear corneal incisions in phacoemulsification. *Int J Recent Trends Sci Technol.* 2015;14(3):112-119.
- Narendran R, Agarwal V, Desai N, et al. Factors affecting visual outcomes after small-incision cataract surgery in rural India: the Sankara Nethralaya Cataract Study. *J Cataract Refract Surg.* 2020;46(1):112-119.
- Tejedor J, Murube J. Choosing the location of corneal incision based on preexisting astigmatism in phacoemulsification. *Am J Ophthalmol.* 2005;139(5):112-119.
- Hayashi K, Hayashi H, Nakao F, Hayashi F. Corneal shape changes after temporal and superior small-incision cataract surgery. *Ophthalmology.* 2001;108(5):737-42