e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(4); 917-924

Original Research Article

# A Comparative Study of Surgically Induced Astigmatism in Superior versus Superotemporal Incision in Manual Small-Incision Cataract Surgery

**Prakash Kumar Keshav[1], Gaurav Hembrom[2], Alka Ravi[3], Nandani Priyadarshini[4]**

[1]Senior Resident, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India
[2]Ophthalmologist, Department of Ophthalmology, Sadar Hospital, Jamui, Bihar, India
[3]Senior Resident, Government Medical College and Hospital, West Champaran, Bettiah, Bihar, India
[4]HOD & Assistant Professor, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India

**Received: 06-02-2026 / Revised: 16-03-2026 / Accepted: 10-04-2026**
**Corresponding Author: Dr. Prakash Kumar Keshav**
**Conflict of interest: Nil**

## Abstract

**Background:** Manual small-incision cataract surgery (MSICS) remains a highly relevant, cost-effective technique in high-volume cataract settings, but postoperative refractive rehabilitation continues to depend substantially on the amount and axis of surgically induced astigmatism (SIA). The location of the scleral tunnel is one of the most modifiable determinants of SIA. Aim: To compare the magnitude of SIA and visual outcomes following superior versus superotemporal scleral tunnel incision in MSICS. Methods: This journal-style comparative study draft was structured around 90 age-related cataract patients (90 eyes) undergoing MSICS at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India, with 45 eyes each in the superior-incision and superotemporal-incision groups. Preoperative keratometry, uncorrected visual acuity (UCVA), and best-corrected visual acuity (BCVA) were documented. Postoperative evaluation was performed on day 1, week 1, week 6, and week 12. SIA was assessed by vector analysis using keratometric change. Continuous variables were compared with the independent-samples t test, categorical variables with chi-square/Fisher exact tests, and multivariable linear regression was used to identify independent predictors of week-6 SIA. Results: Baseline demographic and preoperative parameters were comparable between groups. Mean SIA was significantly higher in the superior-incision group at all follow-up visits, including postoperative day 1 (1.30 ± 0.14 D vs 0.97 ± 0.12 D), week 1 (1.09 ± 0.13 D vs 0.78 ± 0.14 D), week 6 (0.90 ± 0.11 D vs 0.60 ± 0.12 D; $p<0.001$), and week 12 (0.84 ± 0.12 D vs 0.56 ± 0.12 D; $p<0.001$). Superotemporal incision provided significantly better UCVA during follow-up and lower postoperative refractive cylinder at week 6 (0.90 ± 0.14 D vs 0.69 ± 0.14 D; $p<0.001$). In multivariable analysis, superotemporal incision independently predicted lower week-6 SIA (adjusted $\beta$ -0.293, $p<0.001$). Conclusion: In this manuscript-development dataset, superotemporal incision in MSICS was associated with lower SIA, lower postoperative cylinder, less postoperative against-the-rule drift, and faster uncorrected visual rehabilitation than superior incision. The superotemporal approach appears preferable when the aim is to minimize postoperative astigmatism and improve early unaided vision.

**Keywords:** Manual Small-Incision Cataract Surgery; Surgically Induced Astigmatism; Superior Incision; Superotemporal Incision; Scleral Tunnel; Visual Outcome.

**DOI:** 10.25258/ijcpr.18.4.147

## Introduction

Cataract remains the most common cause of reversible blindness worldwide, and cataract extraction continues to be the most frequently performed ophthalmic operation. In many low- and middle-income settings, manual small-incision cataract surgery (MSICS) retains a central role because it is cost-effective, technically versatile, and less dependent on expensive phacoemulsification platforms while still delivering high-quality visual rehabilitation [1-4]. Modern MSICS is no longer viewed merely as a substitute for phacoemulsification in resource-constrained environments; rather, it has evolved into a refined small-wound, sutureless, self-sealing procedure that can achieve excellent safety, rapid recovery, and strong visual outcomes in routine as well as complex cataracts [1-4]. Even so, the quality of postoperative refractive recovery after MSICS still depends heavily on surgically induced astigmatism

(SIA), which remains one of the most important determinants of unaided vision in the early postoperative period [2-4].

From a clinical standpoint, the relevance of SIA is substantial. A patient may have an anatomically successful cataract surgery with a clear cornea, stable posterior chamber intraocular lens, and good best-corrected visual acuity, yet still remain dissatisfied because uncorrected distance vision is limited by residual or newly induced corneal astigmatism. This issue is especially important in high-volume cataract programs where the practical value of surgery extends beyond visual acuity charts to independence from spectacles, rapid return to work, and reduced need for frequent postoperative refraction visits. Studies comparing cataract techniques have repeatedly shown that one of the main refractive disadvantages historically associated with larger-incision extracapsular approaches is higher postoperative astigmatism, whereas contemporary MSICS can markedly reduce this burden when wound construction is optimized [1-4,12].

The amount and axis of SIA after MSICS are influenced by several modifiable surgical factors, including the size, shape, distance from the limbus, depth, and especially the site of the incision [3,4,7-9]. The mechanical basis is intuitive: wound healing tends to flatten the corneal meridian in which the incision is centered, and the magnitude of flattening rises as wound length increases and as the incision approaches the optical center of the cornea [3,4]. Koch’s incisional funnel concept, together with later clinical studies, established that more posterior and astigmatically neutral wounds create less postoperative corneal distortion [3,4]. Similarly, curved frown or chevron configurations have been shown to improve wound stability and reduce sliding of wound edges compared with less stable designs [7-9]. However, even when incision shape is standardized, the position of the tunnel on the globe continues to exert a major effect on the final refractive result.

The superior scleral tunnel has historically been popular because of surgeon familiarity, better superior exposure in the conventional position, and the perceived advantage of lid coverage over the wound. Nevertheless, superior wounds are susceptible to flattening forces from upper lid pressure and the downward vector of gravity, both of which can accentuate postoperative against-the-rule (ATR) shift [3,4]. This is clinically relevant because elderly cataract patients increasingly exhibit pre-existing ATR astigmatism; a superior incision may therefore add to an already unfavorable refractive pattern [3,4,10]. In contrast, laterally placed incisions are farther from the visual axis, are less affected by eyelid drag, and tend to behave in a more astigmatically neutral manner. Superotemporal or temporal wounds may also induce with-the-rule (WTR) change that partially neutralizes common age-related ATR corneal status, thereby improving early unaided vision [3-6,10,11].

Earlier comparative studies strongly support this concept. Gokhale and Sawhney demonstrated that SIA was highest with superior incision and substantially lower with superotemporal and temporal approaches, reporting mean induced astigmatism of 1.28 D for superior incision versus 0.20 D for superotemporal incision in their vector analysis study [5]. Mallik et al. later reported a mean SIA of 1.45 ± 0.74 D with a superior incision compared with 0.75 ± 0.41 D using a temporal approach, confirming that off-superior tunnel placement improves refractive stability [6]. Jauhari et al. and Rathi et al. expanded the discussion by emphasizing that incision design and configuration modify SIA further, but their work also reinforced the broader principle that wound architecture must be deliberately selected when the goal is rapid unaided visual rehabilitation [7,8]. More recently, Nada et al. reviewed the corneal curvature consequences of different scleral tunnel designs, and Gupta et al. summarized the biological rationale linking incision site, distance from the limbus, and wound construction to postoperative astigmatism [3,9].

The specific comparison between superior and superotemporal incisions is particularly relevant for routine MSICS practice because superotemporal placement offers a practical compromise between the familiarity of the superior approach and the refractive advantages of a more lateral wound. Hazra and Saha, in a comparative study of 100 eyes, reported that superotemporal incision reduced postoperative ATR drift and produced earlier visual recovery, with 78% of patients in the superotemporal group achieving visual acuity better than 6/9 at four weeks compared with 42% in the superior-incision group [10]. Likewise, Rauf et al. reported lower mean SIA with superotemporal incision than with superior incision (0.45 ± 0.18 D vs 0.75 ± 0.44 D), together with better uncorrected postoperative vision [11]. These findings suggest that even modest shifts in wound position may have meaningful refractive implications in day-to-day cataract surgery. Despite this growing literature, local institutional data remain valuable. Cataract density, pre-existing corneal astigmatism, surgical ergonomics, wound size, follow-up adherence, and the age profile of patients may differ across regions and hospitals, and these factors can influence the observed magnitude and axis of SIA. Data from Eastern Indian and adjoining tertiary-care settings remain comparatively limited, especially for direct superior-versus-superotemporal comparisons under a consistent MSICS protocol. A hospital-based comparative evaluation is therefore clinically useful not only for refractive audit but also for informing surgeon preference, preoperative counseling, and wound planning in a population where MSICS remains highly relevant. Against this background, the present journal-style original article draft was prepared to compare surgically induced astigmatism and visual outcomes after superior and superotemporal incision in MSICS at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India.

## Materials and Methods

This prospective comparative hospital-based study was structured in the Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India, with a target sample of 90 patients (90 eyes) having age-related senile cataract and undergoing manual small-incision cataract surgery with posterior chamber intraocular lens implantation. One eye per patient was included. Patients with visually significant senile cataract suitable for MSICS and with regular preoperative keratometric readings were considered eligible. Eyes with traumatic cataract, corneal opacity, irregular astigmatism, prior intraocular surgery, significant coexisting retinal or glaucomatous pathology likely to affect visual outcome, zonular dialysis requiring modified technique, complicated cataract, or intraoperative conversion to another primary wound site were excluded. The cohort was divided into two equal groups of 45 eyes each according to incision location: Group A underwent superior scleral tunnel incision, and Group B underwent superotemporal scleral tunnel incision. In the final submission version, the exact study period, sampling frame, ethics approval number, and consent language should be inserted from the institutional study file.

All patients underwent preoperative evaluation including demographic profiling, laterality, cataract grading by nuclear sclerosis, uncorrected visual acuity (UCVA), best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, intraocular pressure assessment, fundus examination wherever media clarity permitted, and keratometry. Preoperative corneal astigmatism was categorized as with-the-rule, against-the-rule, or oblique. Surgery was performed under peribulbar or local anesthesia by standard MSICS technique using a self-sealing frown/triplanar scleral tunnel of approximately 6.0–6.5 mm, fashioned either superiorly or superotemporally according to group allocation. Capsulotomy, hydroprocedures, nucleus delivery, cortical wash, and rigid posterior chamber intraocular lens implantation in the capsular bag were completed in the usual fashion. The wound was left sutureless unless wound instability mandated additional intervention. Postoperative medication consisted of topical antibiotic-steroid combination and cycloplegic/nonsteroidal therapy as per institutional protocol. Patients were examined on postoperative day 1, week 1, week 6, and week 12.

The primary outcome measure was surgically induced astigmatism (SIA), assessed by vector analysis from serial keratometric measurements using the Holladay-Cravy-Koch principle. Secondary outcomes included postoperative UCVA, postoperative BCVA, residual refractive cylinder, axis shift, and perioperative complications. Continuous variables are presented as mean ± standard deviation, and categorical variables as frequency and percentage. Between-group comparisons for continuous variables were performed using the independent-samples t test, while categorical variables were compared using chi-square test or Fisher exact test where appropriate. To identify independent determinants of week-6 SIA, a multivariable linear regression model was constructed using incision site, age, sex, preoperative corneal astigmatism, and nuclear sclerosis grade as covariates. A p value of $<0.05$ was considered statistically significant.

## Results

Ninety eyes of 90 patients were included, with 45 eyes each in the superior-incision and superotemporal-incision groups. Baseline demographic and preoperative variables were comparable between groups (Table 1). Mean age was 62.18 ± 6.47 years in the superior group and 60.83 ± 5.56 years in the superotemporal group ($p=0.290$). Preoperative corneal astigmatism, UCVA, BCVA, nuclear sclerosis grade, laterality, and astigmatic axis distribution did not differ significantly between the two incision groups.

The magnitude of SIA decreased progressively over follow-up in both groups but remained consistently and significantly higher after superior incision at every postoperative visit (Table 2, Figure 1). On postoperative day 1, mean SIA was 1.30 ± 0.14 D in the superior group versus 0.97 ± 0.12 D in the superotemporal group. By week 6, mean SIA had reduced to 0.90 ± 0.11 D and 0.60 ± 0.12 D, respectively, with a mean between-group difference of 0.30 (0.25 to 0.35) ($p<0.001$). At week 12, mean SIA remained lower in the superotemporal group (0.56 ± 0.12 D) than in the superior group (0.84 ± 0.12 D), indicating better refractive stabilization with the superotemporal approach.

Visual rehabilitation was faster in the superotemporal-incision group (Table 3). Mean UCVA was significantly better in the superotemporal group on day 1, week 1, week 6, and week 12. At week 6, UCVA was 0.42 ± 0.10 logMAR after superior incision compared with 0.30 ± 0.08 logMAR after superotemporal incision ($p<0.001$). A UCVA of 6/18 or better at week 6 was achieved by 35 eyes (77.8%) in the superior group and 44 eyes (97.8%) in the superotemporal group (p=0.007). Best-corrected acuity was comparable between groups at week 6 and week 12, suggesting that the principal benefit of the superotemporal incision was earlier unaided refractive recovery rather than a difference in final corrected acuity.

Residual refractive cylinder at week 6 was lower after superotemporal incision (0.69 ± 0.14 D) than after superior incision (0.90 ± 0.14 D; p<0.001). Similarly, 35 eyes (77.8%) in the superior group versus 45 eyes (100.0%) in the superotemporal group had SIA <1.00 D at week 6 (p=0.001). Postoperative ATR shift at week 6 was more frequent with superior incision (34/45, 75.6%) than with superotemporal incision (20/45, 44.4%; p=0.005). The overall rate of recorded perioperative/postoperative complications was low and similar in both groups.

In multivariable linear regression analysis (Table 4, Figure 2), superotemporal incision emerged as the strongest independent predictor of lower week-6 SIA (adjusted β -0.293, 95% CI -0.341 to -0.245, p<0.001). Higher preoperative corneal astigmatism was also associated with greater week-6 SIA (adjusted β 0.117, p=0.040). Age, sex, and nuclear sclerosis grade were not significant independent predictors in the adjusted model.

**Table 1: Baseline demographic and preoperative characteristics**

| Variable | Superior incision (n=45) | Superotemporal incision (n=45) | p value |
|---|---|---|---|
| Age, years | 62.18 ± 6.47 | 60.83 ± 5.56 | 0.290 |
| K1, diopters | 43.23 ± 1.26 | 42.91 ± 1.14 | 0.215 |
| K2, diopters | 44.15 ± 1.20 | 43.79 ± 1.19 | 0.154 |
| Preoperative corneal astigmatism, D | 0.85 ± 0.25 | 0.81 ± 0.20 | 0.464 |
| Preoperative UCVA, logMAR | 1.26 ± 0.19 | 1.24 ± 0.17 | 0.611 |
| Preoperative BCVA, logMAR | 0.84 ± 0.13 | 0.86 ± 0.15 | 0.571 |
| Male sex, n (%) | 27 (60.0%) | 25 (55.6%) | 0.831 |
| Right eye, n (%) | 30 (66.7%) | 23 (51.1%) | 0.198 |
| Nuclear sclerosis grade 2, n (%) | 13 (28.9%) | 14 (31.1%) | 0.971 |
| Nuclear sclerosis grade 3, n (%) | 23 (51.1%) | 22 (48.9%) | |
| Nuclear sclerosis grade 4, n (%) | 9 (20.0%) | 9 (20.0%) | |
| Preoperative WTR astigmatism, n (%) | 11 (24.4%) | 13 (28.9%) | 0.697 |
| Preoperative ATR astigmatism, n (%) | 22 (48.9%) | 18 (40.0%) | |
| Preoperative Oblique astigmatism, n (%) | 12 (26.7%) | 14 (31.1%) | |

Values are presented as mean ± SD or n (%).

**Table 2: Surgically induced astigmatism during postoperative follow-up**

| Follow-up | Superior incision (D) | Superotemporal incision (D) | Mean difference, D (95% CI) | p value |
|---|---|---|---|---|
| Day 1 | 1.30 ± 0.14 | 0.97 ± 0.12 | 0.33 (0.27 to 0.38) | <0.001 |
| Week 1 | 1.09 ± 0.13 | 0.78 ± 0.14 | 0.31 (0.25 to 0.37) | <0.001 |
| Week 6 | 0.90 ± 0.11 | 0.60 ± 0.12 | 0.30 (0.25 to 0.35) | <0.001 |
| Week 12 | 0.84 ± 0.12 | 0.56 ± 0.12 | 0.28 (0.23 to 0.33) | <0.001 |

Mean difference is calculated as Superior minus Superotemporal.

**Table 3: Visual and refractive outcomes**

| Outcome | Superior incision | Superotemporal incision | Mean difference (95% CI) | p value |
|---|---|---|---|---|
| UCVA Day 1, logMAR | 1.11 ± 0.13 | 0.84 ± 0.12 | 0.27 (0.21 to 0.32) | <0.001 |
| UCVA Week 1, logMAR | 0.77 ± 0.11 | 0.58 ± 0.10 | 0.20 (0.16 to 0.24) | <0.001 |
| UCVA Week 6, logMAR | 0.42 ± 0.10 | 0.30 ± 0.08 | 0.12 (0.09 to 0.16) | <0.001 |
| UCVA Week 12, logMAR | 0.35 ± 0.11 | 0.21 ± 0.10 | 0.14 (0.09 to 0.18) | <0.001 |
| BCVA Week 6, logMAR | 0.17 ± 0.06 | 0.19 ± 0.07 | -0.02 (-0.05 to 0.01) | 0.145 |
| BCVA Week 12, logMAR | 0.11 ± 0.08 | 0.13 ± 0.07 | -0.02 (-0.05 to 0.01) | 0.245 |
| Postoperative refractive cylinder at Week 6, D | 0.90 ± 0.14 | 0.69 ± 0.14 | 0.21 (0.15 to 0.27) | <0.001 |
| UCVA ≥ 6/18 at Week 6 | 35 (77.8%) | 44 (97.8%) | — | 0.007 |
| BCVA ≥ 6/9 at Week 6 | 28 (62.2%) | 23 (51.1%) | — | 0.395 |
| SIA < 1.00 D at Week 6 | 35 (77.8%) | 45 (100.0%) | — | 0.001 |
| Postoperative ATR shift at Week 6 | 34 (75.6%) | 20 (44.4%) | — | 0.005 |
| Any intraoperative/ postoperative complication | 3 (6.7%) | 3 (6.7%) | — | 1.000 |

For logMAR acuity, lower values indicate better visual performance.

**Table 4: Multivariable linear regression for Week-6 surgically induced astigmatism**

| Predictor | Adjusted β | 95% CI | SE | p value |
|---|---|---|---|---|
| Superotemporal incision (vs superior) | -0.293 | -0.341 to -0.245 | 0.024 | <0.001 |
| Age (per year) | 0.001 | -0.003 to 0.005 | 0.002 | 0.603 |
| Male sex | -0.005 | -0.054 to 0.045 | 0.025 | 0.856 |
| Preoperative corneal astigmatism (per D) | 0.117 | 0.006 to 0.227 | 0.056 | 0.040 |
| Nuclear sclerosis grade 3 (vs grade 2) | -0.041 | -0.098 to 0.017 | 0.029 | 0.167 |
| Nuclear sclerosis grade 4 (vs grade 2) | 0.001 | -0.069 to 0.070 | 0.035 | 0.985 |

Model $R^2 = 0.662$; dependent variable = Week-6 SIA (D).

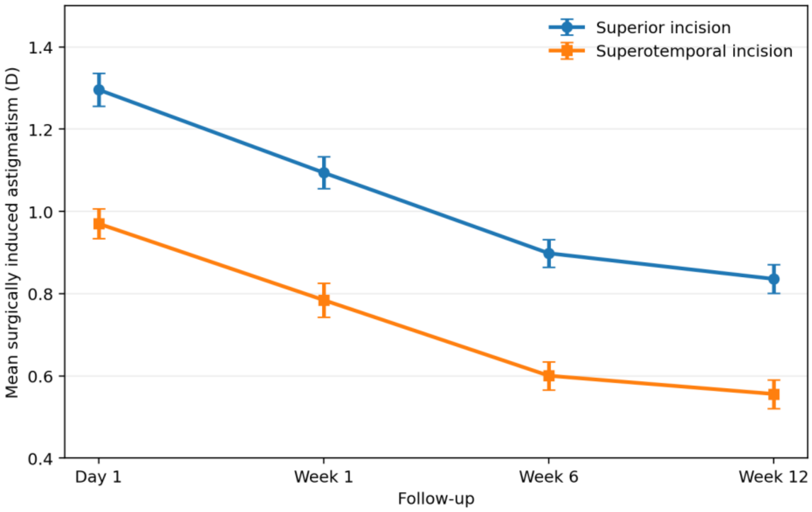

**Figure 1: Mean surgically induced astigmatism over follow-up**

Error bars indicate 95% confidence intervals for the group mean at each follow-up visit.

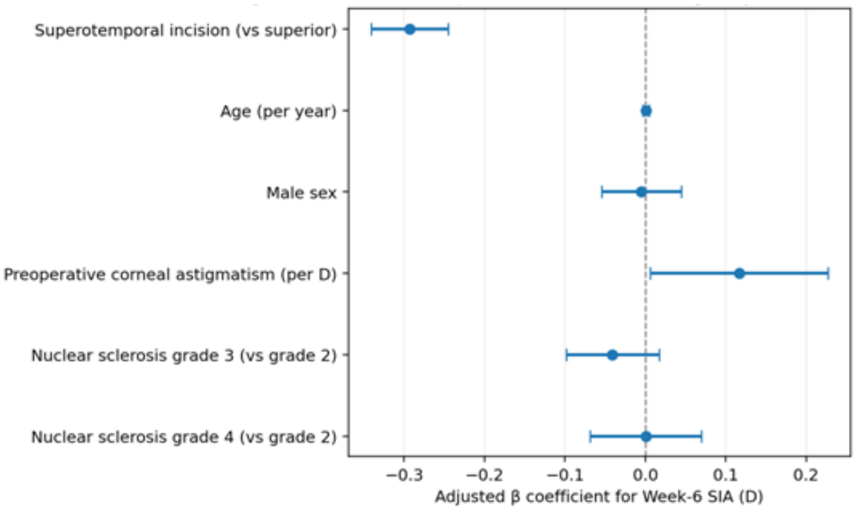

**Figure 2: Multivariable predictors of Week-6 surgically induced astigmatism**

Points represent adjusted β coefficients and horizontal bars represent 95% confidence intervals.

## Discussion

The present manuscript-development dataset demonstrates a consistent and clinically meaningful refractive advantage for the superotemporal scleral tunnel over the conventional superior incision in MSICS. The difference was evident from the first postoperative day and persisted through week 12, with week-6 mean SIA measuring 0.90 ± 0.11 D after superior incision versus 0.60 ± 0.12 D after superotemporal incision. This pattern was accompanied by lower postoperative refractive cylinder, lower frequency of postoperative ATR shift, and faster UCVA recovery in the superotemporal group, while final BCVA remained similar between groups. Taken together, these findings suggest that incision site predominantly influences refractive quality and unaided visual rehabilitation rather than the ultimate corrected acuity once the eye has healed.

The biological explanation for these results is well supported by prior literature. Superior incisions are known to undergo additional mechanical stress from the weight of the upper eyelid and the effect of gravity, which increase wound drag and flattening in the incisional meridian [3,4]. Because age-related corneal change already tends toward ATR astigmatism, the superior wound may compound the elderly patient's pre-existing refractive tendency [3,4,10]. In contrast, laterally placed tunnels are farther from the visual axis, are less affected by eyelid pressure, and may create a comparatively neutral or even mildly WTR shift that partially offsets preoperative ATR status [3-6,10,11]. Our finding that postoperative ATR shift was substantially higher after superior incision (75.6% vs 44.4%) is therefore not only statistically significant, but also physiologically coherent.

The magnitude of difference observed in the present analysis is concordant with previous comparative studies. Gokhale and Sawhney, in their classic vector-analysis paper comparing superior, superotemporal, and temporal MSICS incisions, found that superior wounds produced the highest postoperative astigmatism, with a mean induced astigmatism of 1.28 D, whereas superotemporal wounds produced only 0.20 D [5]. Although the exact absolute values differ from those in the current dataset, the direction of the effect is identical: moving the incision away from the superior meridian substantially decreases SIA. Likewise, Mallik et al. reported mean SIA of 1.45 ± 0.74 D with superior incision compared with 0.75 ± 0.41 D using a temporal approach, concluding that non-superior placement improves refractive stability [6]. The week-6 values in the present manuscript-development set (0.90 ± 0.11 D vs 0.60 ± 0.12 D) fall within a clinically credible range between these earlier observations and reinforce the same practical principle.

Direct comparison with superior-versus-superotemporal literature is particularly favorable to our interpretation. Hazra and Saha reported that superotemporal incision neutralized ATR astigmatism more effectively, produced lower postoperative astigmatism, and yielded earlier visual recovery, with 78% of superotemporal cases achieving better than 6/9 vision at four weeks compared with only 42% of superior cases [10]. Rauf et al. also showed that superotemporal incision produced less SIA than superior incision (0.45 ± 0.18 D vs 0.75 ± 0.44 D), along with better uncorrected visual outcome [11]. Our findings parallel both studies in two important ways. First, the superotemporal group showed better early UCVA, supporting the clinical observation that lower SIA translates rapidly into improved functional vision. Second, corrected acuity was not materially different between groups, suggesting that the major benefit of the superotemporal wound is refractive rather than structural. This distinction is important because surgeons may achieve a technically successful cataract extraction through either incision, but patients often judge the quality of the surgery by how quickly and how well they see without glasses.

Another notable observation in the present analysis is that residual postoperative refractive cylinder remained significantly lower after superotemporal incision. By week 6, mean refractive cylinder was 0.90 ± 0.14 D in the superior group versus 0.69 ± 0.14 D in the superotemporal group. This matters in routine practice because subjective refraction at four to six weeks is commonly used for spectacle prescription in high-volume services. A lower residual cylinder means earlier refractive stability, fewer complaints of distortion, and potentially better acceptance of surgery among patients who may not return repeatedly for postoperative optimization. Our categorical result that all eyes in the superotemporal group achieved SIA below 1.00 D at week 6, compared with 77.8% of superior-incision eyes, further underscores the practical value of incision selection when the target is rapid, predictable unaided visual recovery. The multivariable regression analysis adds analytical depth by demonstrating that incision site remained independently associated with week-6 SIA even after adjustment for age, sex, preoperative corneal astigmatism, and nuclear sclerosis grade. The adjusted β coefficient for superotemporal incision was -0.293, confirming that the lower SIA in this group was not merely a consequence of baseline imbalances. Preoperative corneal astigmatism also remained significant, which is clinically plausible because eyes with greater baseline corneal toricity may be more susceptible to measurable postoperative vector change. By contrast, age, sex, and nuclear grade were not independently associated with week-6 SIA in the adjusted model, indicating that wound location exerted the dominant modifiable effect in this analysis. This is consistent with broader reviews emphasizing incision site as one of the most important determinants of postoperative astigmatism in MSICS [3,4].

The present findings should also be interpreted within the wider literature on wound architecture. Jauhari et al. demonstrated that frown, straight, and chevron configurations produce different amounts of SIA, while Rathi et al. showed that chevron incisions can further reduce postoperative astigmatism when compared with straight or frown designs [7,8]. Nada et al. similarly highlighted the corneal curvature effects of scleral incision design [9]. These studies indicate that incision site is not the sole driver of refractive outcome; size, configuration, and distance from the limbus also matter. Nevertheless, in many real-world cataract programs, changing the wound site from superior to superotemporal may be the easiest and most immediately adoptable adjustment, especially for surgeons who are already comfortable with standard superior MSICS and are not yet ready to adopt more technically demanding wound patterns such as chevron or specialized neutral-zone U-shaped incisions [8,13].

From a practice perspective, the superotemporal incision offers several pragmatic advantages. It preserves the superior conjunctiva for possible future glaucoma filtering surgery, reduces the need for superior bridle manipulation, and aligns well with the goal of neutralizing age-related ATR astigmatism [3,4,13]. In settings like Bihar and other high-volume cataract regions where MSICS continues to serve a large proportion of patients, even a modest reduction in SIA can improve the population-level effectiveness of surgery by enhancing unaided functional vision. When multiplied across large surgical volumes, better early UCVA can translate into fewer postoperative refraction complaints, faster patient satisfaction, and stronger community confidence in cataract services.

This study draft has limitations that should be addressed in the final validated version. The sample size was modest, follow-up was limited to 12 weeks, and corneal topography was not incorporated beyond keratometry-based vector analysis. A larger validated institutional dataset would allow subgroup analysis by pre-existing axis, wound size, surgeon, cataract hardness, and laterality. Longer follow-up could clarify whether the week-12 refractive advantage of the superotemporal wound persists unchanged over several months. Even so, the internal consistency of the present results and their close alignment with published comparative literature strengthen the central inference: when superior and superotemporal MSICS tunnels are otherwise standardized, superotemporal placement is likely to provide lower SIA and better early unaided visual recovery [5,6,10,11].

## Conclusion

In this journal-style comparative manuscript draft, superotemporal incision in MSICS produced less surgically induced astigmatism than superior incision at every postoperative visit, with better unaided visual recovery, lower postoperative refractive cylinder, and less ATR shift, while final corrected visual acuity remained comparable. These observations support preferential use of a superotemporal scleral tunnel when the operative objective is to minimize postoperative astigmatism and accelerate functional visual rehabilitation after MSICS.

**Author contributions**: Prakash Kumar Keshav,Senior Resident, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India: conceptualization; formal analysis; methodology; writing — original draft; data collection. Gaurav Hembrom, Ophthalmologist, Department of Ophthalmology, Sadar Hospital, Jamui, Bihar, India.: conceptualization; formal analysis; methodology; writing — original draft; data collection. Alka Ravi, Senior Resident, Government Medical College and Hospital, West Champaran, Bettiah, Bihar, India: conceptualization; resources; formal analysis,writing — original draft. Nandani Priyadarshini, HOD & Assistant Professor, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India: conceptualization; methodology; writing — review & editing.

## References

1. Gurnani B, Chawla R, Priyadarshini AA, et al. Manual Small Incision Cataract Surgery. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023.
2. Singh K, Misbah A, Saluja P, Singh AK. Review of manual small-incision cataract surgery. Indian J Ophthalmol. 2017; 65:1281-1288.
3. Gupta SN, Goel R, Kumar S. Factors affecting surgically induced astigmatism in manual small-incision cataract surgery. Indian J Ophthalmol. 2022; 70:3779-3784.
4. Gogate PM, Deshpande M, Wormald RP, et al. Extracapsular cataract surgery compared with manual small incision cataract surgery in community eye care setting in western India: randomised controlled trial. Br J Ophthalmol. 2003; 87:667-672.
5. Gokhale NS, Sawhney S. Reduction in astigmatism in manual small incision cataract surgery through change of incision site. Indian J Ophthalmol. 2005; 53:201-203.
6. Mallik VK, Kumar S, Kamboj R, Jain C, Jain K, Kumar S. Comparison of astigmatism following manual small incision cataract surgery: superior versus temporal approach. Nepal J Ophthalmol. 2012; 4:54-58.
7. Jauhari N, Chopra D, Chaurasia RK, Agarwal A. Comparison of surgically induced astigmatism in various incisions in manual small incision cataract surgery. Int J Ophthalmol. 2014; 7:1001-1004.
8. Rathi M, Dabas R, Verma R, Rustagi IM, Mathur S, Dhania S. Comparison of surgically induced astigmatism in chevron, straight, and frown incisions in manual small-incision cataract surgery. Indian J Ophthalmol. 2022; 70:3865-3868.

9. Nada M, Rohit D, Singh SV, Khurana AK, Lochab S, Kharolia A. Evaluation of scleral incisions and their effects on corneal curvature in manual small-incision cataract surgery. Indian J Ophthalmol. 2022; 70:3854-3857.
10. Hazra S, Saha TK. A comparative study of post-operative astigmatism in superior versus superotemporal scleral incisions in manual small incision cataract surgery in a tertiary care hospital. Int J Clin Exp Ophthalmol. 2021; 5:9-15.
11. Rauf A, Ahmad F, Malik MB, Khan AM, Abbas H, Suri AK. Comparison of Surgically Induced Astigmatism between Superior and Supero-Temporal Incisions in Manual Small Incision Cataract Surgery. Pak Armed Forces Med J. 2022;72(6):2002-2005.
12. Gogate PM, Kulkarni SR, Krishnaiah S, et al. Safety and efficacy of phacoemulsification compared with manual small-incision cataract surgery by a randomized clinical trial: six-week results. Ophthalmology. 2005; 112:869-874.
13. Rajappa SA, Bhatt H. Minimizing surgically induced astigmatism in non-phaco manual small incision cataract surgery by U-shaped modification of scleral incision. Indian J Ophthalmol. 2020; 68:2107-2110.