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Original Research Article

EFFECT OF INCISION SITE AND SIZE ON SURGICALLY INDUCED ASTIGMATISM AND VISUAL OUTCOMES IN NON-PHACO SMALL INCISION CATARACT SURGERY

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ABSTRACT

Background: The objective is to evaluate the impact of incision site and size on surgically induced astigmatism (SIA) and postoperative visual acuity in patients undergoing manual small incision cataract surgery (MSICS).
Materials and Methods: The prospective comparative study included 113 eyes of 112 patients on whom MSICS was done. There was variation in incision sites (superior, supero-temporal, and temporal) and incision sizes (5.5 mm, 6 mm, and 6.5 mm). Patients were grouped based on site and size of incision. The postoperative uncorrected visual acuity (UCVA) and SIA were assessed at 6 months after surgery. SIA was evaluated using Jaffe and Clayman's vector analysis. ANOVA (Analysis of Variance) was used for statistical analysis.
Results: At 6 months post-surgery, UCVA ≥6/12 was achieved in 70% of patients with a 5.5 mm incision, 66% of patients with a 6 mm incision, and 58% of patients with a 6.5 mm incision. Among incision sites, the supero-temporal group showed the best outcomes (79% UCVA ≥6/12), followed by the temporal group (64%) and superior group (61%). SIA was lowest in the supero-temporal group (0.54 D to 0.72 D), followed by the temporal group (0.70 D to 1.10 D), and highest in the superior group (1.02 D to 1.33 D). A significant shift toward against the rule astigmatism was noted in 62% of cases. Differences among the study groups were statistically significant ($p < 0.05$).
Conclusion: The site and size of incision significantly affects visual outcomes and SIA in MSICS. Supero-temporal incisions and smaller incision sizes (5.5 mm) are associated with lower surgery-induced astigmatism and better uncorrected visual outcomes.
Keywords: Manual small incision cataract surgery, surgically induced astigmatism, incision site, incision size, vector analysis, visual acuity.

INTRODUCTION

Surgically induced astigmatism (SIA), exerts a significant influence on postoperative visual outcomes after cataract surgery.[1] Among the most influential variables contributing to SIA are the site and size of the surgical incision.[2] The superolateral and temporal incisions have been shown to produce less distortion of the cornea compared to superior incisions.[3,4] The advanced vector analysis techniques have further made it possible to precisely quantify the magnitude and direction of SIA.[5,6]

Research studies indicate that smaller incisions significantly reduce postoperative astigmatism.[7,8] Also, the wound strength and the pattern of healing differ with the site and depth of the incision, affecting the corneal curvature and refraction.[9] The frown incision has been shown to produce a slower decay of induced astigmatism, offering longer-term stability.[10]

Posterior limbal and chevron incisions have been shown to minimise SIA.[11,12] The incision site and size directly impact wound healing and postoperative refractive outcomes.[13]

The use of refractive vector analysis, as described by Holladay et al., provides deeper insights into surgically induced refractive shifts.[14] The no-stitch frown incisions and lateral approach incisions have demonstrated better outcomes in reducing against-the-rule astigmatism.[15,16]

The need for standard reporting and calculation of SIA is increasingly recognised.[17] Incision site and size must be determined considering the limbal architecture and corneal periphery.[18] The understanding of the wound construction is essential to achieve consistent results.[19]

Recent developments in software-based SIA calculation, have made it easier to compare vector-derived results with traditional mathematical methods, providing greater precision in clinical practice.[20]

With this background, the present study assessed how different incision sites (superior, supero-temporal, and temporal) and incision sizes (5.5 mm, 6.0 mm, and 6.5 mm) affect surgically induced astigmatism (SIA) and uncorrected visual acuity after manual small incision cataract surgery (MSICS).

MATERIALS AND METHODS

Patient Selection: A total of 113 eyes of 112 patients diagnosed with age-related cataract were included.

Inclusion criteria were:

(a) Senile cataract,
(b) No prior ocular surgery or trauma, and
(c) Corneal astigmatism <1.5D preoperatively.

Exclusion criteria were:

(a) Irregular astigmatism,
(b) Corneal dystrophies,
(c) Glaucoma,
(d) Retinal pathology, and
(e) Intraoperative complications.

Grouping and Surgical Technique

Patients were assigned to three groups based on incision site (superior, supero-temporal, and temporal) and three subgroups based on incision size (5.5 mm, 6.0 mm, and 6.5 mm).

All surgeries were performed by a single experienced surgeon using a standardised MSICS technique. A self-sealing sclerocorneal tunnel was constructed using a crescent blade. Incision sizes were accurately measured using Castroviejo callipers.

The nucleus was delivered using an irrigating vectis after capsulorhexis and hydrodissection. A rigid PMMA posterior chamber intraocular lens was implanted in the capsular bag. The wound was assessed for self-sealing properties; no sutures were placed unless required.

Postoperative Management and Follow-up

Postoperative treatment included topical antibiotics and corticosteroids tapered over six weeks. Patients were examined at 1 week, 6 weeks, and 6 months. At each follow-up, slit-lamp biomicroscopy and visual acuity testing were performed. Posterior segment evaluation was done by indirect ophthalmoscopy.

Outcome Measures

1. Uncorrected Visual Acuity (UCVA) and Best-Corrected Visual Acuity (BCVA) were assessed using a Snellen chart and converted to LogMAR for statistical analysis.
2. Keratometric Astigmatism was recorded using a manual Bausch & Lomb keratometer preoperatively and at each postoperative visit.
3. Surgically Induced Astigmatism (SIA) was calculated using Jaffe and Clayman's vector analysis method, which remains the standard for objective assessment.[1,5,14]

Statistical Analysis: Data were compiled using Microsoft Excel and analysed with SPSS (Statistical Package for the Social Sciences). Quantitative variables were expressed as mean ± standard deviation. Group comparisons of SIA and UCVA were done using one-way ANOVA. A p-value of <0.05 was considered statistically significant.

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Advanced vector techniques such as those developed by Alpins have helped refine the interpretation of SIA,[6] and have been incorporated in comparative studies evaluating incision dynamics.[11–13,15–17] Software-based tools such as SIA-Soft were also used to validate manual calculations.[20]

Incision sites were classified anatomically as shown in Figure

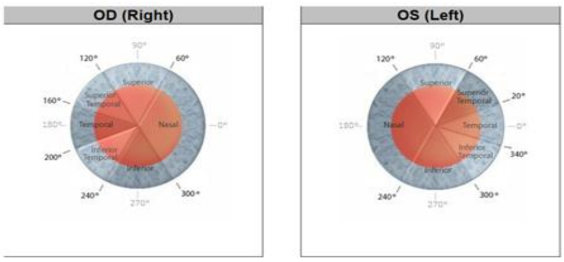

Figure 1: ?

Statistical Analysis: Data were compiled using Microsoft Excel and analyzed with SPSS (Statistical Package for the Social Sciences) a software program used by researchers in various disciplines for quantitative analysis of complex data. Quantitative variables were expressed as mean ± standard deviation. Group comparisons of SIA and UCVA were done using one-way ANOVA. A p-value of <0.05 was considered statistically significant. Previous literature has emphasized the importance of statistical rigor and standardization in SIA reporting.[17–19]

RESULTS

Surgically Induced Astigmatism by Incision Location
A total of 113 eyes were included, with 53 in Group 1 and 60 in Group 2. The mean surgically induced astigmatism (SIA) varied notably based on incision location across both groups. In Group 1, superior incisions resulted in the highest mean SIA of 1.06 D, followed by temporal incisions (0.86 D) and supero-temporal incisions (0.59 D). In Group 2, this pattern persisted, with superior incisions again producing the highest SIA (1.31 D), temporal incisions showing a moderate increase (1.09 D), and supero-temporal incisions yielding the lowest value (0.64 D).
The overall mean SIA was 0.85 D in Group 1 and 1.02 D in Group 2. Nasal, inferior, and inferior-temporal incisions were not employed in either cohort [Table 1].

Table 1: Comparison of Surgically Induced Astigmatism by Incision Location

Incision Location	Surgically Induced Astigmatism (D) (Group 1, n=53)	Number of Patients	Surgically Induced Astigmatism (D) (Group 2, n=60)	Number of Patients
Temporal	0.86	13	1.09	20
Nasal	0.00	0	0.00	0
Superior	1.06	22	1.31	21
Inferior	0.00	0	0.00	0
Superior Temporal	0.59	18	0.64	19
Inferior Temporal	0.00	0	0.00	0
Overall SIA	0.85	53	1.02	60

Statistical analysis using one-way ANOVA revealed a significant difference in mean SIA between incision groups ($p < 0.05$), with supero-temporal incisions associated with the least induced astigmatism in both cohorts. This supports the premise that incision geometry plays a critical role in postoperative refractive outcomes, particularly in minimizing corneal distortion.

DISCUSSION

The present study demonstrates association between incision site and the magnitude of surgically induced astigmatism (SIA) in MSICS. Our findings confirm that superior incisions induce significantly higher SIA compared to supero-temporal and temporal approaches.[1,2]
Hayashi et al., have illustrated how superior incisions lead to steepening of the vertical meridian, leading to a greater shift towards-against the rule astigmatism.[3] Conversely, supero-temporal incisions respect the preoperative corneal contour more closely, minimizing postoperative refractive change.[4] The application of vector analysis methods as described by Alpins and refined in subsequent work,[5,6] allows for objective quantification of astigmatic change and confirms the stability of supero-temporal incisions in our cohort.
Our results align with previous prospective studies, including Steinert et al. who demonstrated that lateral incisions produce lower astigmatism.[7] Furthermore, incision size and site play important role in astigmatism, as large or poorly designed wounds may compromise corneal curvature integrity.[9,10]
Koch's structural analysis supports the concept that incision design must balance wound stability with minimal corneal deformation, an approach increasingly validated by modern vector models.[13,14] Our findings on superior incisions causing higher SIA are corroborated by Sinskey and Axt, who documented similar trends in no-stitch and lateral incision techniques.[15,16]
Standardization of SIA measurement, advocated by Goggin,[17] and incorporation of limbal architecture considerations (as emphasized by Ernest,[18]) are essential to optimising refractive outcomes.

CONCLUSION

This study confirms that both the site and size of the incision play a major role in surgically induced astigmatism (SIA) in manual small incision cataract surgery (MSICS). Superior incisions were linked to higher levels of astigmatism, while supero-temporal incisions resulted in less SIA and better uncorrected vision. This, in turn, contributes to better uncorrected visual acuity, faster visual rehabilitation, and overall improved patient satisfaction following manual small incision cataract surgery.

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