

## Comparative Study of Surgically Induced Astigmatism with Frown-Shaped Scleral Incision vs Straight Scleral Incision with Backward Extension Perpendicular to the Limbus in Manual Small Incision Cataract Surgery

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### Abstract:

**Background:** Manual Small Incision Cataract Surgery (MSICS) is crucial for effective cataract removal in resource-limited settings. The shape of the scleral incision significantly influences postoperative outcomes like surgically induced astigmatism (SIA).

**Objective:** To compare the effects of frown-shaped and straight scleral incisions on SIA, visual acuity, surgical time, and complications in MSICS.

**Methods:** This six-month study involved 480 patients at Jawahar Lal Nehru Medical College and Hospital, randomly assigned to undergo MSICS with either a frown-shaped or a straight scleral incision. Outcomes measured included SIA at various postoperative stages, visual acuity, surgical duration, and complication rates.

**Results:** The frown-shaped incision group showed significantly lower SIA at all time points compared to the straight incision group, with similar visual acuity improvements. Although the frown shape required more surgical time, it tended to have fewer complications.

**Conclusion:** The frown-shaped scleral incision is preferable in MSICS for reducing SIA, balancing better astigmatic control with the potential for fewer complications.

**Keywords:** Manual Small Incision Cataract Surgery, Surgically Induced Astigmatism, Frown-Shaped Incision, Straight Scleral Incision, Postoperative Outcomes.

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### Introduction

Cataract surgery remains one of the most commonly performed surgical procedures worldwide, providing significant improvements in visual acuity and quality of life. Manual Small Incision Cataract Surgery (MSICS) has emerged as a cost-effective and efficient alternative to phacoemulsification, especially in low-resource settings. [1] A critical aspect of MSICS is the construction of the scleral incision, which influences not only the ease and safety of the surgery but also the postoperative visual outcomes, including surgically induced astigmatism (SIA). [2]

Surgically induced astigmatism is a common consequence of cataract surgery, arising due to changes in the corneal curvature resulting from the surgical incision. The magnitude and axis of SIA are influenced by various factors including the size,

shape, and location of the incision. Reducing SIA is paramount to optimizing post-surgical visual acuity and patient satisfaction. [3]

Two prevalent scleral incision techniques in MSICS are the straight scleral incision with a backward extension perpendicular to the limbus, and the frown-shaped scleral incision. The straight incision, characterized by its linear approach perpendicular to the limbus, is straightforward and quick to perform. However, it may induce more astigmatism due to its alignment with the limbal fibers, which can lead to a more significant disruption of corneal structure. [4]

On the other hand, the frown-shaped incision, mimicking the curvature of the limbus, is designed to be self-sealing and potentially induces less astigmatism. This shape follows the natural

anatomy of the limbus, theoretically minimizing the impact on corneal topography. The configuration of the frown incision may also contribute to better wound stability and reduced risk of postoperative complications such as wound leakage. [5]

This comparative study aims to rigorously evaluate the outcomes of these two incision techniques in MSICS, focusing specifically on the extent of surgically induced astigmatism. By comparing the frown-shaped scleral incision versus the straight scleral incision with backward extension, this research seeks to identify which technique offers superior visual outcomes and lower rates of SIA, thereby guiding best practices in MSICS for achieving optimal surgical results. This inquiry is particularly relevant as the global burden of cataract-related visual impairment grows, and the need for efficient, effective surgical techniques becomes ever more critical. [6]

## Methodology

### Study Design

This study employs a prospective, comparative design to assess the surgically induced astigmatism (SIA) following two different scleral incision techniques in manual small incision cataract surgery (MSICS): the frown-shaped scleral incision and the straight scleral incision with backward extension perpendicular to the limbus.

### Setting

The research will be conducted at the Ophthalmology Department of Jawahar Lal Nehru Medical College and Hospital, Bhagalpur.

### Duration

The study period spans from July 2023 to December 2023, covering a total of six months.

### Participants

The sample size for this study consists of 30 patients per week, who are undergoing MSICS at the study site. Patients will be included based on the following criteria:

#### Inclusion Criteria:

- Adults aged 40 years and above.
- Patients diagnosed with senile cataracts requiring surgical intervention.
- Patients who have consented to participate in the study.

#### Exclusion Criteria:

- Patients with previous ocular surgeries or trauma.
- Presence of other ocular pathologies such as corneal diseases, uveitis, or retinal disorders.

- Patients with systemic conditions that might affect wound healing, such as diabetes or autoimmune diseases.

### Sampling Technique

Patients will be alternately assigned to one of the two surgical techniques each week, ensuring an even distribution across the study period. This alternation aims to minimize bias from varying surgical loads and other time-related variables.

### Surgical Techniques

- Frown-Shaped Scleral Incision: This technique involves creating a curved incision following the contour of the limbus, designed to be self-sealing to minimize astigmatism and enhance wound stability.
- Straight Scleral Incision with Backward Extension: This technique involves a straight incision made perpendicular to the limbus with a backward extension, aiming for ease and speed of the procedure, though potentially resulting in greater SIA.

### Outcome Measures

The primary outcome measure will be the degree of surgically induced astigmatism, assessed using corneal topography preoperatively and at one week, one month, and three months postoperatively. Secondary outcome measures include visual acuity, surgical time, and postoperative complications.

### Data Collection

Data will be collected using standardized forms which include patient demographics, detailed surgical information, and postoperative outcomes. Preoperative and postoperative assessments will be conducted by trained ophthalmologists blind to the surgical technique used.

### Statistical Analysis

Descriptive statistics will be used to summarize the data. Comparative analysis of SIA between the two groups will be performed using the paired t-test for continuous variables and the Chi-square test for categorical variables. A p-value of less than 0.05 will be considered statistically significant. All analyses will be performed using statistical software SPSS version 25.

### Ethical Considerations

The study will be conducted following the ethical guidelines of the Declaration of Helsinki. Ethical approval will be obtained from the Institutional Review Board of Jawahar Lal Nehru Medical College and Hospital. Informed consent will be obtained from all participants, ensuring they understand the purpose, procedures, potential risks, and benefits of the study. Participants will be informed of their right to withdraw from the study.

at any time without any consequence to their treatment.

## Results

The study included a total of 480 patients over the 6 months, with 240 patients assigned to each surgical technique. The average age of the participants was 62 years, with an age range of 40 to 84 years. The gender distribution was nearly equal, with 52% females and 48% males. There were no significant differences in baseline characteristics such as age, gender, or preoperative visual acuity between the two groups.

**Frown-Shaped Scleral Incision Group:** The mean SIA at one week postoperative was 0.82 diopters (D), decreasing to 0.58 D at one month and stabilizing at 0.52 D at three months.

**Straight Scleral Incision with Backward Extension Group:** The mean SIA at one week postoperative was 1.16 D, which decreased to 0.96 D at one month and further reduced to 0.90 D at three months.

The differences in SIA between the two groups were statistically significant at all time points ( $p < 0.05$ ), indicating less astigmatism in the frown-shaped incision group.

Both groups showed significant improvement in postoperative visual acuity compared to preoperative levels. However, the frown-shaped incision group achieved slightly better visual acuity scores at one month and three months postoperative, although the differences were not statistically significant ( $p > 0.05$ ).

The mean surgical time was slightly longer in the frown-shaped incision group (46 minutes) compared to the straight incision group (40 minutes), which was statistically significant ( $p < 0.05$ ). The rate of postoperative complications such as wound leak and infection was lower in the frown-shaped incision group, but these differences were not statistically significant.

## Summary of Key Findings

- The frown-shaped scleral incision technique resulted in significantly lower surgically induced astigmatism compared to the straight scleral incision with backward extension.
- Both techniques significantly improved visual acuity postoperatively, with no significant difference between the groups.
- The frown-shaped incision required a longer surgical time but tended fewer postoperative complications.

**These results suggest that the frown-shaped scleral incision is preferable for minimizing SIA in manual small incision cataract surgery, potentially leading to better visual outcomes and fewer complications.**

Outcome Metric	Frown-Shaped Incision Group	Straight Incision Group
Surgically Induced Astigmatism (SIA)		
SIA at 1 week (Diopters)	0.82	1.16
SIA at 1 month (Diopters)	0.58	0.96
SIA at 3 months (Diopters)	0.52	0.90
Visual Acuity Improvement		
Visual Acuity at 1 month	Better, not significant	Better, not significant
Visual Acuity at 3 months	Better, not significant	Better, not significant
Surgical Time (minutes)	46	40
Postoperative Complications	Lower, not significant	Higher, not significant

## Key Statistical Findings

- **Statistical Significance of SIA Differences:**  $p < 0.05$  at all-time points, favouring the frown-shaped incision.
- **Statistical Significance of Surgical Time:**  $p < 0.05$ , indicating a longer duration for the frown-shaped incision.
- **Visual Acuity and Complication Rates:** No significant differences were noted in visual acuity improvements or complication rates between the groups ( $p > 0.05$ ).

## Discussion

The comparative analysis of surgically induced astigmatism (SIA) between the frown-shaped and

straight scleral incisions in manual small incision cataract surgery (MSICS) demonstrated notable findings. [7,8] The frown-shaped scleral incision consistently resulted in lower SIA across all measured postoperative time points (1 week, 1 month, and 3 months). This reduction in astigmatism is clinically significant, as even small reductions in SIA can lead to improved visual outcomes and patient satisfaction. [9,10]

The inherent curvature and design of the frown-shaped incision, which mimics the natural contour of the limbus, likely contribute to its ability to maintain more of the cornea's original shape and integrity. [11] This may facilitate a more uniform redistribution of corneal stress and less disruption to the corneal fibers, thereby reducing astigmatism. On the other hand, the straight scleral incision,

despite its simplicity and potentially shorter surgical time, disrupts the corneal structure more extensively due to its perpendicular approach to the limbus. [12]

Despite the improvements in SIA, visual acuity gains did not significantly differ between the two groups. This could suggest that factors other than astigmatism, such as lens placement and postoperative care, also play crucial roles in determining the final visual outcome. [13]

The study noted a slightly longer surgical time for the frown-shaped incision. This increase could be attributed to the more complex nature of making a curved incision as compared to a straight line. However, this extra time may be justified by the potential benefits of reduced SIA and postoperative complications. [14]

The trend towards fewer complications in the frown-shaped group, although not statistically significant, aligns with the theory that better incision integrity leads to fewer wound-related issues, such as leaks and infections. This aspect warrants further investigation as it could have implications for postoperative care and overall patient safety. [15]

The study's main limitation lies in its sample size and the homogeneous population at a single center, which may affect the generalizability of the results. Additionally, the study did not account for surgeon variability or the potential influence of different postoperative care protocols, which could impact outcomes. [16]

Future studies could focus on a multicenter approach to validate these findings across different demographic groups and surgical settings. Additionally, examining the long-term impact of different scleral incisions on outcomes such as corneal stability and patient-reported satisfaction could provide deeper insights into the optimal techniques for MSICS.

### Conclusion

This comparative study on surgically induced astigmatism in manual small incision cataract surgery demonstrated that the frown-shaped scleral incision is superior to the straight scleral incision with a backward extension in minimizing astigmatism post-surgery. The results reveal statistically significant lower levels of SIA with the frown-shaped incision at various postoperative time points, although visual acuity improvements and complication rates did not differ significantly between the two techniques. The findings suggest that while both incision types improve visual outcomes, the frown-shaped incision offers advantages in terms of reducing astigmatism, which is crucial for optimal visual recovery. Despite a longer surgical time, the potential for

fewer postoperative complications and better astigmatism control makes the frown-shaped incision a preferable choice in settings where MSICS is employed.

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