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Original Research Article

A comparative study on surgically induced astigmatism in frown vs. chevron incision in manual small incision cataract surgery

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Abstract

Background: Astigmatism is a common postoperative complication of cataract surgery, significantly affecting visual outcomes. In Manual Small Incision Cataract Surgery (MSICS), the incision type critically influences surgically induced astigmatism (SIA). Frown and chevron incisions, with their distinct geometries within the astigmatic funnel, are commonly used to reduce SIA. Comparing outcomes from these incisions aims to guide surgical technique selection and enhance postoperative visual performance after MSICS.

Aim and Objectives: To compare surgically induced astigmatism following frown versus chevron incisions in Manual Small Incision Cataract Surgery (MSICS).

Materials and Methods: Ninety patients within age group 41-80 with cataract were randomly assigned to either the frown incision group or the chevron incision group. Preoperative assessments included detailed ocular history, visual acuity, intraocular pressure, and keratometry. All surgeries were performed by a single surgeon under standardized conditions. Postoperative evaluations included keratometry, UCVA, and BCVA on day 30. SIA was calculated using keratometric readings pre- and post-operatively.

Results: The chevron incision group demonstrated significantly less surgically induced astigmatism (mean SIA: 0.38 ± 0.141) compared to the frown incision group (mean SIA: 0.82 ± 0.319). Additionally, the chevron incision group showed similar visual acuity outcomes in terms of UCVA and BCVA compared to the frown incision group.

Conclusion: Chevron incisions in MSICS result in significantly less surgically induced astigmatism and similar visual acuity outcomes compared to frown incisions. Hence suggests that chevron incisions may be preferable for optimizing postoperative visual outcomes in patients undergoing MSICS.

Keywords: Surgically induced astigmatism, Frown incision, Chevron incision, MSICS, Keratometry.

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1. Introduction

Cataract surgery is one of the most common and successful surgical procedures performed worldwide, aimed at restoring vision in patients with cataracts.[1]

Steinert highlights the importance of incision type in cataract surgery, emphasizing its influence on postoperative astigmatism outcomes.[2] Agarwal et al. discuss various techniques in ophthalmic surgery, noting the role of incision geometry in determining SIA.[3] Davis et al. describe the evolution of cataract surgery techniques, underscoring the impact of surgical approach on visual outcomes.[4] Duke-Elder provides a comprehensive overview of eye surgery, detailing the significance of precise incision techniques in minimizing complications such as astigmatism.[5] Hennig offers a practical guide to MSICS, illustrating how different incision designs can affect the degree of surgically induced astigmatism.[6]

There exists a concept of astigmatic funnel radiating from the inside outwards, the narrowest part of the funnel placed on the limbus and the flared peripheral portion on the sclera. It has been postulated that cornea and scleral incisions made with in this funnel will induce the least amount of

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postsurgical astigmatism.[7] Researchers also found that because this funnel is flaring towards the sclera, incision made further away from the limbus was better in addition they also found that the curvilinear incision made at the opposite direction of the limbus frown, an inverted V or chevron,[8] inverted boat shaped or Blumenthal incision have a tendency to lie totally with in astigmatic funnel and therefore will induce least astigmatism, therefore these have become the choice for surgeons who have adopted the art.

With advancements in surgical techniques, the focus has shifted towards minimizing postoperative complications, particularly surgically induced astigmatism (SIA), which can significantly affect visual outcomes. Various incision techniques have been developed to achieve this goal, with the frown and chevron incisions being two of the most widely used in Manual Small Incision Cataract Surgery (MSICS).

The frown incision, characterized by its curved shape, is believed to provide a more self-sealing wound, reducing the risk of postoperative complications and minimizing SIA.[7] The chevron incision, on the other hand, is designed to distribute tension more evenly across the wound, potentially offering better control over astigmatism.[9] Previous studies have provided mixed results regarding the superiority of one incision type over the other. For instance, Rathi et al. found no significant difference in SIA between frown and straight incisions in MSICS.[7] Rathi et al. reported that chevron incisions resulted in slightly lower SIA compared to frown incisions.[9] As the local literature contains limited information, this study aims to fill this gap in research by comparing the surgical induced astigmatism and visual outcomes of frown versus chevron incisions in a cohort of patients undergoing MSICS.

2. Materials and Methods

This cross sectional study was conducted at the Department of Ophthalmology, Sri Sathya Sai Medical College and Research Institute, from March 2022 to July 2024. A total of 90 patients diagnosed with senile cataracts and scheduled for MSICS were enrolled in the study. The patients were divided into two groups based on the type of incision used: 45 patients in the frown incision group and 45 patients in the chevron incision group.

Inclusion criteria for the study included patients aged 40 to 80 years, diagnosed with cataracts requiring surgical intervention, no history of ocular trauma or previous ocular surgery, clear cornea, and normal anterior segment anatomy. Exclusion criteria included patients with corneal pathologies or irregular astigmatism, previous ocular surgeries or trauma, systemic conditions affecting wound healing (e.g., diabetes mellitus), and intraoperative complications affecting the incision site.

All patients underwent a thorough preoperative assessment, including a detailed medical history to document any systemic or ocular conditions, a comprehensive ocular examination including slit-lamp biomicroscopy, intraocular pressure measurement, and dilated fundus examination. Keratometry was used to measure the corneal curvature, and UCVA and BCVA were recorded using a Snellen chart.

All surgeries were performed by the same experienced surgeon to eliminate inter-surgeon variability. Peribulbar block anesthesia was administered for all patients. The frown incision group had a curved, frown-shaped incision made superiorly in the cornea, while the chevron incision group had a chevron-shaped incision made superiorly in the cornea. Manual small incision cataract surgery was performed in the conventional manner for cataract removal. A posterior chamber IOL was implanted in all patients, and the incision was self-sealing with no sutures required.

Postoperative care included standard topical antibiotics and steroids, with follow-up visit was scheduled at 1 month postoperatively. At follow-up visit, UCVA and BCVA were measured using a Snellen chart, keratometry was conducted to assess changes in corneal curvature and calculate SIA, and slit-lamp examination was performed to evaluate the incision site and anterior segment on post operative day 30.

Data on age, gender, UCVA, BCVA, and keratometric readings were collected preoperatively and postoperatively. SIA was calculated using the vector analysis method. Statistical analysis was performed using SPSS software, with descriptive statistics used to summarize demographic data. Independent t-test was used to compare the SIA between the two groups. A p-value of <0.05 was considered statistically significant.

3. Results

The mean age in the frown incision group was 64.24 years and in the chevron incision group, it was 59.86 years.

In the frown group, the majority of patients fall within the 61-70 years age range (18 patients), followed by 51-60 years (15 patients), 71-80 years (7 patients), 41-50 years (3 patients), and 81-90 years (2 patients). In the chevron group, the largest number of patients are in the 51-60 years range (17 patients), followed by 61-70 years (11 patients), 41-50 years (10 patients), 71-80 years (5 patients), and 81-90 years (2 patients). The P value of 0.534 was obtained that indicates that the age distribution differences between the two groups are not statistically significant, suggesting that the age distribution in both groups is similar and that age is unlikely to be a confounding factor in comparing the surgical outcomes between the two incision types.

The gender distribution was 21 males and 24 females in the frown incision group, and 20 males and 25 females in the chevron incision group.

The higher no. of patients were in the post-op UCVA is 6/6-6/9 and 6/9-6/12 was observed and shown in **Table 1**.

Similarly, very lower no. of patients were observed in the post-op UCVA is 6/12-6/18. The p-value of the post-op UCVA is 0.321 > 0.05 which was statistically insignificant.

In chevron group patients, the higher no. of patients was observed in the post-op BCVA of 6/6-6/9 shown in **Table 2**. In frown group patients, the higher no. of patients was observed in the post-op BCVA of 6/6-6/9. The p-value of the post-op BCVA is 0.452 > 0.05 statistically insignificant was observed.

The mean SIA of the patients among the groups were calculated and given in **Table 3**. The higher mean SIA of the patients were observed in frown group patients and shown in **Table 3**. The p-value of the mean SIA is 0.00001 < 0.05 statistically significant was observed.

Table 1: Post-op UCVA of the patients among the groups

Post-op UCVA	Frown group	Chevron group
6/6-6/9	19	25
6/9-6/12	18	16
6/12-6/18	8	4
P value	0.321	

Table 2: Post-op BCVA of the patients among the groups

Pre op BCVA	Frown group	Chevron group
6/6-6/9	34	38
6/9-6/12	10	6
6/12-6/18	1	1
P VALUE	0.452	

Table 3: Mean SIA of the patients among the groups

SIA	Frown group	Chevron group
Mean	0.892	0.381
SD	0.571	0.143
p value	<0.00001	

4. Discussion

This study aimed to compare surgically induced astigmatism (SIA) following frown versus chevron incisions in Manual Small Incision Cataract Surgery (MSICS). Our findings indicate that both incision types result in minimal SIA and significant improvements in visual acuity, with no significant difference between the two groups in terms of postoperative outcomes.

Both UCVA and BCVA improved significantly in the postoperative period for both groups. This improvement aligns with the general expectation that cataract surgery markedly enhances visual acuity. The absence of a significant difference between the groups suggests that both incision techniques are equally effective in achieving favorable visual outcomes. These results are consistent with previous studies, such as one conducted by Rathi et al., which also reported comparable improvements in visual acuity following different incision techniques in MSICS.[7]

Both UCVA and BCVA improved significantly in the postoperative period for both groups. Post-op UCVA in Frown group was 19 patients between 6/6-6/9, 18 patients between 6/9-6/12 and 8 patients between 6/12-6/18. In Chevron group was 25 patients between 6/6-6/9, 16 patients between 6/9-6/12 and 4 patients between 6/12-6/18.

Post-op BCVA in Frown group was between 6/6-6/9 in 34 patients, 10 patients between 6/9-6/12 and 1 patient between 6/12-6/18. In Chevron group, 38 patients had best corrected visual acuity between 6/6-6/9, 6 patients between 6/9-6/12 and 1 patient between 6/12-6/18.

In our study, SIA in Frown group was 0.82±0.319, in Chevron group was 0.38±0.141, suggesting that inverted v or chevron incision causes lesser SIA following MSICS.

This minor difference suggests that while both incision types are effective in minimizing astigmatism, the chevron incision may have a slight advantage in controlling astigmatism.

Similar findings were reported in a study by Rathi et al., who compared the SIA in MSICS using frown and chevron incisions and reported similar outcomes, with both techniques resulting in minimal SIA and significant visual improvement where the chevron incision was associated with marginally lower SIA compared to the frown incision.[9]

Our findings are in line with several other studies that have compared different incision techniques in cataract surgery. For instance, a study by Rathi et al. evaluated the SIA in MSICS with frown and straight incisions and found no significant difference in SIA between the two groups.[7] However, some studies have reported varying degrees of SIA with different incision techniques. For example, a study by Chandra et al. found that straight incisions tend to induce more astigmatism compared to curved incisions, such as the frown and chevron.[10] This suggests that the shape and placement of the incision can influence the extent of SIA, with curved incisions generally being more favorable in minimizing astigmatism.

Another study by Choudhary et al. highlighted the importance of incision architecture in controlling SIA. They compared arcuate incisions with straight incisions and found that arcuate incisions were more effective in reducing astigmatism.[11] Similarly, a study by Archana et al. compared scleral tunnel incisions with corneal incisions and reported lower SIA with scleral tunnel incisions.[12] Venkatesh et al. highlighted the evolving techniques in MSICS and the importance of incision type on postoperative outcomes.[13] Various other studies like Amesbury et al and Kongsap et al reviewed various techniques for astigmatism correction

including the shape of incision during cataract surgery, noting the critical role of surgical approach in minimizing postoperative astigmatism.[14,15] These studies underscore the role of incision design in determining postoperative astigmatism and support the findings of our study.

One of the strengths of our study is the prospective design and the standardized surgical procedure performed by a single experienced surgeon, which reduces inter-surgeon variability. However, there are also limitations to our study. The sample size, while adequate, could be increased in future studies to improve the generalizability of the findings. Additionally, longer follow-up periods would provide more insight into the stability of SIA over time. Furthermore, future research could explore the impact of different surgical techniques on other visual outcomes, such as contrast sensitivity and patient satisfaction.

5. Limitations

As the sample size of the study was small and this was a cross-sectional study, we would need further studies with larger sample sizes and longer follow-up periods.

6. Conclusion

Both frown and chevron incisions in MSICS result in minimal surgically induced astigmatism and significant improvements in visual acuity. While the chevron incision may offer a slight advantage in controlling surgically induced astigmatism, the difference in visual acuity was not statistically significant. Through comprehensive data analysis and comparison, this study contributes valuable insights into refining surgical techniques to minimize SIA and enhance visual acuity outcomes in cataract surgery. The findings support the recommendation for incorporating chevron incisions as a preferred technique in MSICS to achieve superior clinical outcomes, thereby advancing the field towards improved patient care and satisfaction.

Future studies with larger sample sizes and longer follow-up periods are warranted to confirm these findings and further explore the impact of incision techniques on visual outcomes in cataract surgery.

7. Source of Funding

None.

8. Conflict of Interest

None.

9. Ethical Approval

Ethical No.: 2022/796.

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