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Research Protocol

Ophthalmology Section

Efficacy of Chevron versus Frown Incisions and Surgically Induced Astigmatism in Small Incision Cataract Surgery: A Research Protocol

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ABSTRACT

Introduction: Cataracts are a leading cause of treatable blindness worldwide, significantly affecting vision, particularly in the elderly. While various surgical techniques exist, Manual Small Incision Cataract Surgery (MSICS) remains a common option, especially in resource-limited settings.

Need for the Study: The magnitude of Surgically Induced Astigmatism (SIA) is primarily influenced by the corneal incision. Incision size, shape, and axis can be modified to minimise SIA and optimise postoperative outcomes. A key challenge in cataract surgery is managing SIA, which can hinder optimal visual results. The present study will evaluate different incision types used in MSICS, including chevron, frown, and straight incisions, examining their impact on SIA and wound integrity. The discussion highlights the evolution of incision techniques aimed at minimising astigmatism and achieving better visual acuity for cataract patients.

Aim: To evaluate the efficacy of chevron versus frown incisions in preventing SIA in small-incision cataract surgery.

Materials and Methods: A two-arm parallel randomised controlled trial will be conducted in the Department of Ophthalmology, Acharya Vinoba Bhave Rural Hospital, Sawangi, Maharashtra, India, from June 2024 to June 2026. A total of 116 patients will be included and allocated into two groups (Group C and Group F), 58 in each. Keratometry readings, Uncorrected Visual Acuity (UCVA), and slit-lamp examination will be performed at each follow-up visit to assess postoperative outcomes. The statistical analyses will compare the magnitude of SIA between the Chevron and Frown incision groups using an independent t-test, and changes in the axis of astigmatism will be analysed using the Chi-square test. A p-value <0.05 will be considered statistically significant.

Keywords: Blindness, Cataract surgery, Incision, Ocular injuries, Surgical astigmatism

INTRODUCTION

The crystalline lens of the human eye becomes opaque when a cataract develops, which inevitably impairs vision [1]. Although congenital forms of the condition can affect young people, it primarily affects the elderly [2]. Cataracts have a wide range of causes and risk factors. Genetic factors, sex, ethnicity, metabolic disorders, ocular injuries, radiation exposure, drug use, and lifestyle are among them [3].

According to the World Health Organisation (WHO), cataracts account for 48% of cases of treatable blindness worldwide. In India, about four million people go blind each year due to cataracts, accounting for 51% of all blindness in the country. Of these, 10 million cases are operable, but only five million cataract procedures are performed annually. Extracapsular Cataract Extraction (ECCE) was once used to treat cataracts; however, the procedure increases astigmatism. Due to its high cost, phacoemulsification is not widely used in low-income countries. Because cataracts are highly prevalent, camps are often used to provide treatment. Phacoemulsification cannot be performed in camps due to cost, making MSICS the primary option in such settings [4].

The basic goal of cataract surgery and the patient's primary expectation is good Uncorrected Visual Acuity (UCVA); however, SIA remains a barrier to this goal. SIA refers to astigmatic changes induced by corneal surgery. The location, duration, and type of surgical incision are all significant factors influencing SIA [5,6]. SIA is further influenced by the method of wound closure, the extent of scleral cauterization, healing of the incision, and the placement of the Intraocular Lens (IOL) [6]. Depending on the size of the incision, the average SIA following MSICS ranges from 1.0 to 3.0 Diopters (D) [7].

The MSICS surgical method is continually evolving. The goal of modern cataract surgery is to provide both astigmatism-free, high visual acuity and improved vision. Astigmatism control with surgery is now a crucial component of cataract surgery. The position, dimensions, and shape of the external incision, together with the orientation of the wound, greatly influence the surgical outcome [8]. As the primary and most significant factor influencing postoperative astigmatism, incisions can be altered in size, shape, and axis in a variety of ways to lessen SIA. One modification to reduce pre-existing Against-The-Rule (ATR) astigmatism and improve the visual result is to place the incision temporally across the vertical meridian [9].

In clinical practice, there has been considerable attention given to the forms of the incisions made during cataract surgery. In 1990, McFarland created the first sutureless straight incision [10]; shortly after, Pallin reported a chevron-shaped incision [11]. In the same time frame, Singer introduced the frown incision [12], which was subsequently shown to minimise surgically induced astigmatism more effectively than the straight incision [13]. To reduce postoperative astigmatism, scleral incisions such as chevron, frown, and straight incisions are used in MSICS [14].

The chevron incision entails making an incision that resembles an inverted V, with an apex located about 1.5 mm from the limbus and an angle between the two arms of roughly 120 degrees (range 100-120°). A review of the literature indicates that the chevron incision is optimal during MSICS. The primary benefit of the chevron incision, especially in cases with hard brown cataracts, is its substantial decrease in surgically induced astigmatism compared with alternative incision techniques [9]. The straight incision is the most common and easiest incision for ophthalmologists to learn and perform when

they first begin doing MSICS. Because of their design, the chevron and frown incisions are more challenging to master. This increases the risk of corneal endothelial injury and bag entanglement while attempting nucleus delivery using an irrigating Vectis [15,16].

Later research has shown that frown and straight incisions cause the least SIA [16]. Nevertheless, there has been limited investigation and measurement of the impacts on wound integrity, particularly from a mechanical perspective. The effectiveness of chevron versus frown incisions is determined by several factors, including surgical objectives, patient characteristics, and physician preference. Research indicates that although chevron incisions may provide better control over the induction of astigmatism, frown incisions can also be quite successful in reducing SIA, particularly when performed by skilled surgeons [17,18].

REVIEW OF LITERATURE

The UCVA is significantly influenced by the SIA, making it a crucial variable that affects postoperative results and patient satisfaction. To enhance wound healing and minimise SIA, scleral incisions and self-sealing sclerocorneal tunnel techniques were introduced in MSICS during the early 1980s [13].

In MSICS, the type of scleral incision is considered a key factor in determining SIA. A study conducted by Han Y and Qi N analysed the geometrical characteristics of three incision styles: chevron, frown, and straight. They analysed features such as incision length and angles. The study found that for chevron incisions, an optimal angle of 170° resulted in lower Effective Residual Refraction (ERR) values. For frown incisions, a central angle of 6° proved to be ideal. In comparison to straight pre-cuts, both chevron and frown incisions allowed for the use of larger injector sizes. However, the frown incision outperformed the others due to its lower ERR and ease of use. Additionally, the study recommended placing incisions in areas characterised by significant isotropy and a distribution of fibrils to reduce tearing [18].

In a study by Tigga MJ et al., no statistically significant difference in mean best-corrected visual acuity was found between Group-B (Frown incision) and Group-A (Blumenthal incision), both showing minimal astigmatism and similar postoperative outcomes. However, the Blumenthal incision was suggested to be more effective for large nuclei and hard cataracts. The researchers noted limitations such as a small sample size and short monitoring period, indicating a need for further research [19].

Rathi M et al., concluded that the straight, frown, and chevron incisions resulted in the lowest levels of SIA. Key factors influencing postoperative outcomes included the size and shape of the incision, as well as the patient's preoperative astigmatism. In MSICS, the chevron incision achieved the best results regarding low SIA and high visual acuity, especially in patients with preoperative astigmatism [20].

In a separate study by Biswas SK et al., involving 100 patients, astigmatism was evaluated before and after surgery across different groups. The findings showed that the chevron incision significantly impacted astigmatism postsurgery, resulting in a notable increase in SIA [21]. Additionally, another study showed that when comparing various types of incisions, the chevron incision led to significantly lower levels of SIA. However, no statistically significant difference in SIA was observed between the frown and straight incisions [22].

The present study aims to evaluate the efficacy of chevron versus frown incisions and SIA in Small-Incision Cataract Surgery (SICS).

Primary objectives:

- To evaluate the efficacy of frown incisions in preventing SIA in SICS.
- To evaluate the efficacy of chevron incisions in SICS for preventing SIA.

Secondary objectives: To compare the efficacy of chevron versus frown incisions in SICS to prevent SIA, a complication.

Null hypothesis: There will be no significant difference in the mean SIA between chevron and frown incisions in SICS.

Alternative hypothesis: There will be a significant difference in the mean SIA between chevron and frown incisions in SICS.

MATERIALS AND METHODS

A two-arm, parallel-group, single-blind randomised controlled trial will be conducted in the Department of Ophthalmology, Acharya Vinoba Bhave Rural Hospital, Sawangi, Maharashtra, India, from June 2024 to June 2026. A single examiner will conduct the assessments under standard preoperative, intraoperative, and postoperative protocols. The study will commence after obtaining informed consent from the subjects. Ethical approval has been obtained from the Institutional Ethics Committee (IEC) with number DMIHER(DU)/IEC/2024/25, and CTRI registration for the trial has been completed in the Clinical Trial Registry of India, number CTRI/2025/03/081813.

Inclusion criteria:

- Age 45-70 years;
- Male or female;
- Uncomplicated bilateral or unilateral immature senile cataracts or white cataracts;
- No other cause for defective vision other than cataract;
- No history of previous ocular surgery in the operating eye;
- Preoperative astigmatism of less than 1 Diopter (D).

Exclusion criteria:

- Age less than 45 or greater than 70 years;
- Other ocular pathologies including complicated, congenital, and traumatic cataracts;
- Preoperative astigmatism greater than 1 D;
- Immature cataracts associated with other ocular co-morbidities, injury, or prior ocular surgery;
- Intraoperative complications (nucleus drop, posterior capsule rupture) or any systemic disorders (diabetes, hypertension);
- Cases with premature entry or where the wound could not be formed properly;
- Patients unwilling to participate in the study.

Sample size calculation:

$$n1 = n2 = 2\,\frac{(Z_\alpha+Z_\beta)^2\sigma^2}{(\delta)^2}$$

$Z_\alpha = 1.96$

α= Type I error at 5% at both sides two tailed

$Z_\beta = 0.84$=Powerat 80 %

Primary variable: Induced astigmatism

Mean value of induced astigmatism score in group F 12 weeks postoperatively=0.82D

Mean value of induced astigmatism score in group C 12 weeks postoperatively=0.55D

Mean difference=0.27 [20].

Pooled standard deviation σ=0.52

Minimum sample size required.

$$\text{Sample size } N = n1 = n2 = 2\,\frac{(1.96+0.84)^2(0.52)^2}{(0.27)^2} = 58 \text{ per group}$$

After considering the inclusion and exclusion criteria, a total of 116 individuals (58 in the chevron group and 58 in the frown group) suffering from senile cataract visiting the ophthalmology outpatient department will be recruited for the study. Allocation to the two groups will be performed using simple randomisation (coin toss).

Operative Procedure: Small Incision Cataract Surgery

A small self-sealing sclero-corneal tunnel will be created through a superior or temporal incision, depending on pocket depth, with a temporal incision preferred for deeper sockets. Anaesthesia will be provided via peribulbar, retrobulbar, sub-Tenon's injection, or 4% lignocaine. After achieving optimal dilation (mydriasis), a superior rectus bridle suture (4-0 Prolene) will be placed, followed by a conjunctival flap using the fornix, with bipolar diathermy used to control bleeding.

The chevron incision will be a 5-6 mm inverted "V" shape, with the apex 1.5 mm from the limbus, while the frown incision will measure 6-8 mm, depending on the type of cataract. A 24-gauge, 15-degree blade will be used for paracentesis at the 9 o'clock position. Anterior capsular staining with Trypan blue will be followed by washing with Balanced Salt Solution (BSS). A 2.8 mm internal incision will be made perpendicular to the limbus and expanded to 5.2 mm. Continuous curvilinear capsulorhexis will be performed, followed by hydrodissection and nuclear delivery through the incision. After cortex aspiration, a posterior chamber IOL will be implanted. Viscoelastic material will be administered and removed with a Simcoe cannula. The paracentesis port will be sealed with BSS, and the conjunctiva will be closed using bipolar cautery.

Postoperative care will include counseling on eye-drop administration, hygiene, and protective measures such as sunglasses. Patients will follow a regimen of steroid and antibiotic eye drops, tapered over several weeks, with additional medications if there is a posterior capsule rupture.

Primary outcomes:

- Surgically Induced Astigmatism (SIA): Magnitude and axis. Corneal curvature changes will be measured using keratometry (Rexxam Auto Ref-Keratometer ACCUREF K-900). Postoperative evaluations will be conducted at day 1, day 15, and 1 month.
- Visual outcomes: Postoperative UCVA and Best-Corrected Visual Acuity (BCVA) will be assessed at day 1, day 15, and 1 month.

Secondary outcomes:

- Slit-lamp examination: Evaluation of eyelids, conjunctiva, cornea, iris, pupil, anterior chamber depth, angles, and lens with its capsule.
- Fundus examination: Conducted using indirect ophthalmoscopy with a 20-D lens.

STATISTICAL ANALYSIS

The analysis will compare the magnitude of SIA between the chevron and frown incision groups, and changes in the axis of astigmatism will be analysed using the Chi-square test or vector analysis. Postoperative UCVA and BCVA at day 1, day 15, and 1 month will be analysed using repeated measures ANOVA or the Friedman test for within-group comparisons and the Wilcoxon rank-sum test for between-group differences. A p-value <0.05 will be considered significant.

Consent: The authors have obtained and maintained the patients' written informed consent in accordance with international or institutional standards.

REFERENCES

[1] Guzek JP, Anyomi FK, Fiadoyor S, Nyonator F. Prevalence of blindness in people over 40 years in the volta region of ghana. Ghana Med J. 2005;39(2):55-62.
[2] Roberts JE. Ultraviolet radiation as a risk factor for cataract and macular degeneration. Eye Contact Lens. 2011;37(4):246-49.
[3] Bendeddouche K, Assaf E, Emadisson H, Forestier F, Salvanet-Bouccara A. Air bags--sécurité vitale et risques oculaires: Brûlures alcalines et lésions traumatiques profondes. A propos d'un cas [Air bags and eye injuries: Chemical burns and major traumatic ocular lesions--a case study]. J Fr Ophtalmol. 2003;26(8):819-23. French. https://pubmed.ncbi.nlm.nih.gov/14586223/.
[4] Vajpayee RB, Joshi S, Saxena R, Gupta SK. Epidemiology of cataract in India: Combating plans and strategies. Ophthalmic Res. 1999;31(2):86-92. Doi: 10.1159/000055518.
[5] Elders, Duke. Practice of refraction. Edition. 10th New Delhi: Elsevier India Publisher. Elsevier ; Publication date. 1 July 1993, (P) Ltd: 1983. p 65. ISBN-10. 8131233332 ; ISBN-13. 978-8131233337.
[6] Spierer A, Shelah M. Changes in astigmatism after cataract extraction and intraocular lens implantation in children. Eye (Lond). 1999;13(Pt 3a):360-62.
[7] Barequet IS, Yu E, Vitale S, Cassard S, Azar DT, Stark WJ. Astigmatism outcomes of horizontal temporal versus nasal clear corneal incision cataract surgery. J Cataract Refract Surg. 2004;30(2):418-23.
[8] Bernhisel A, Pettey J. Manual small incision cataract surgery. Curr Opin Ophthalmol. 2020;31(1):74-79.
[9] Goel R, Sontakke R, Shah S, Nagpal V, Kumar S, Koli O, et al. Correction of pre-existing astigmatism by on-axis incision size modulation in manual small-incision cataract surgery. Indian J Ophthalmol. 2022 Nov;70(11):3858-863. Doi: 10.4103/ijo.IJO_1603_22.
[10] Haldipurkar SS, Shikari HT, Gokhale V. Wound construction in manual small incision cataract surgery. Indian J Ophthalmol. 2009;57(1):09-13.
[11] Pallin SL. Chevron sutureless closure: A preliminary report. J Cataract Refract Surg. 1991;17 Suppl:706-09. Doi: 10.1016/s0886-3350(13)80687-6.
[12] Singer JA. Frown incision for minimizing induced astigmatism after small incision cataract surgery with rigid optic intraocular lens implantation. J Cataract Refract Surg. 1991;17(Suppl):677-88.
[13] 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(11):3865-68.
[14] American Academy of Ophthalmology Basic & Clinical Science Course. Section 3: Clinical Optics, 2007-2008. San Francisco, CA. American Academy of Ophthalmology; 2007:117-118.
[15] Sinha A, Gurnani B, Kaur K, Niharika J, Bejjenki P, Venkatesh D, et al. Commentary: Surgically induced astigmatism in manual small-incision cataract surgery incision types: Is the correlation linear? Indian J Ophthalmol. 2022;70(11):3869-70.
[16] Yadav RD, Bajracharya K, Shrestha N, Joshi K, Gupta AK. Astigmatic changes in sutureless small incision cataract surgery. Birat J Health Sci 2021;6(1):1280-84.
[17] 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(6):1001-04.
[18] Han Y, Qi N. Numerical study of critical straight, frown, & chevron incisions in small incision cataract surgery. Front Bioeng Biotechnol. 2023;11:1283293.
[19] Tigga MJ, Gupta S, Singh H. Comparative evaluation of surgically induced astigmatism following blumenthal versus frown corneoscleral tunnel incision in MSICS (Manual Small Incision Cataract Surgery). Journal of Cardiovascular Disease Research. 2023;14(05):145-52.
[20] Rathi M, Soni D, Verma R, Sachdeva S, Phogat J. Surgically induced astigmatism in frown versus chevron incision in MSICS. Int J Med Ophthalmol. 2020;2(2):95-97.
[21] Biswas SK, Islam Q, Husain R, Sultana S, Anjum N. Astigmatic change in Manual Small Incision Cataract Surgery (MSICS) with chevron type of incision. International Journal of Innovative Science and Research Technology. 2022;7(4)794-99.
[22] Venkatesan C, Maagnaah S, Venkatesan MJ. Surgically induced astigmatism in manual small-incision cataract surgery: A comparative study between straight, frown & inverted v shape (chevron) incision. International Journal of Toxicological & Pharmacological Research. 2022;12(6):109-14.

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