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**ORIGINAL RESEARCH**

# A Comparative Study of Surgically Induced astigmatism in small Incision Cataract Surgery V/S Phacoemulsification

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## ABSTRACT

**Background:** Cataract is the most common cause of reversible blindness worldwide. Surgical removal of cataractous lens remains the only effective treatment for management of cataract blindness. The success of cataract surgery is determined by best and earliest visual recovery. But the occurrence of postoperative astigmatism has become a major hurdle in achieving this goal.

**Purpose:** The study was designed to compare the amount of surgically induced astigmatism following manual small incision cataract surgery with phacoemulsification.

**Materials and Methods:** This prospective observational study conducted in a tertiary health care institution over a period of 2 years. A total of 100 eyes were randomized into 2 groups. Group 1 was operated by manual small incision cataract surgery (SICS) and Group 2 by phacoemulsification. The patients were followed up post-operatively at day 1 and 1st week and 6th week and 12thweeks. At each follow up Visual Acuity (VA), Refraction and acceptance and Keratometry were recorded and the findings were analyzed for astigmatism. Descriptive statistics and analytical statistics like chi-square test and independent sample t-test were generated. A p-value of<0.05 was taken as level of significance.

**Result:** At the end of 12 weeks post-operatively the mean (SD) surgically induced astigmatism of the phacoemulsification group (0.48±0.14 D) was found to be significantly lower as compared to the SICS group (0.93±0.28D) (p<0.05)

**Conclusion:** The result of the study shows that phacoemulsification is the better technique to control surgically induced astigmatism as compared to manual small incision cataract surgery.



## INTRODUCTION

Cataract is the principal cause of avoidable blindness in India and throughout the world and account for 66.2% blindness in India. [1,2] Surgical removal of cataractous lens remains the only effective treatment for management of cataract blindness. The fundamental aim of cataract surgery is removal of the opacified natural lens and replacing it with an artificial intraocular lens to improve vision. There are different techniques of cataract surgery like conventional extracapsular cataract extraction (ECCE), manual small incision cataract surgery (SICS) and phacoemulsification. [3]

Small Incision Cataract Surgery (SICS) [4] and Phacoemulsification [5] are both commonly used surgical techniques for cataract removal. While both techniques aim to correct vision problems caused by cataracts, they may have different effects on postoperative astigmatism. It can be present before cataract surgery or induced as a result of the surgery itself. [6] The magnitude of astigmatism depends on various factors, including the surgical technique used. Astigmatism is a condition in which imperfections in the curvature of the cornea or lens can cause blurred vision. The amount of astigmatism that develops after cataract surgery can vary depending on the type of surgery performed, the size and location of the incision, and the surgeon's technique. The risk of

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developing postoperative astigmatism after cataract surgery is also affected by several other factors, including preoperative **corneal astigmatism:** [6-8] People with higher levels of preoperative astigmatism is at a higher risk of developing postoperative astigmatism.

The astigmatism also depends on the size and location of the incision. Larger incisions are more likely to cause astigmatism than smaller incisions. The surgeon's technique also matters. Some surgeons are more experienced in minimizing the risk of astigmatism than others. [6-8]

During the Phacoemulsification procedure, the surgeon can also correct pre-existing astigmatism by making additional incisions or using specialized toric intraocular lenses (IOLs) that correct astigmatism.[9] SICS, on the other hand, involves a slightly larger incision and typically does not offer the same degree of astigmatism correction options as Phacoemulsification, although it may be possible to address astigmatism with additional incisions or specialized IOLs in certain cases.[10] In general, Phacoemulsification has the advantage of smaller incisions and more precise surgical control, which may result in less induced astigmatism compared to SICS. The smaller incisions used in Phacoemulsification often lead to faster healing and better visual outcomes. Additionally, the ability to correct astigmatism intraoperatively with toric IOLs or incisions tailored to address astigmatism is an advantage of Phacoemulsification.[11] However, it's important to note that the outcome of postoperative astigmatism can vary depending on several factors, including the surgeon's skill, patient-specific characteristics, pre-existing astigmatism, and the type of IOL implanted.[12] Each surgical technique has its advantages and potential for managing astigmatism, and the choice of technique should be based on individual patient needs and the surgeon's expertise.

## MATERIALS AND METHODS

The single-center, prospective, observational hospital based follow up study was conducted on 100 patients with cataract disease undergoing small incision cataract surgery (N=50) and Phacoemulsification (N=50) admitted to the Department of Ophthalmology, Amaltas Institute of Medical Sciences, Dewas, a tertiary care institute.

Cases included patients with cataract who underwent small incision cataract surgery and Phacoemulsification were admitted 24 hours prior to surgery and complete Ophthalmic and Systemic examination was done in the Department of Ophthalmology.

### Eligibility criteria

Patient aged 45 to 80 years having cataracts that were categorized as either grade-3 or below according to the Lens Opacities Classification System-III (LOCS-III) were included in the study. Patients with any chronic systemic illness, Hypermature cataract/nuclear sclerosis grade more than 3, Corneal disorder, Traumatic Cataract, Glaucoma, Previous intraocular Surgery / pterygium surgery, Macular disorder were excluded from the study.

### Preoperative evaluation:

Credentials of patients were recorded. Detailed history was taken for cataract and other systemic diseases. History was also taken from the wearing of glasses.

In the pre-operative phase of the research study, the following comprehensive set of assessments was performed on the participants undergoing cataract surgery.

i. **Lacrimal passage examination:** Syringing of lacrimal passage was done.
ii. **Visual Acuity:** The visual acuity of each participant was measured using the Snellen's chart following the standard procedure.
iii. **Intraocular Pressure:** Goldmann Contact Applanation tonometer was employed to measure the intraocular pressure.
iv. **Anterior Segment Examination:** A Slit Lamp examination was conducted to carefully inspect the anterior segment of the eye.
v. **Grading of Cataract:** The Lens Opacities Classification System III (LOCS III) was used to categorize and grade the severity of cataracts in participants.
vi. **Keratometry Reading/K1/K2:** Auto refractometer was employed to measure the curvature of the cornea in both horizontal and vertical meridians along the axis and calculate astigmatism.
vii. **Axial Length and IOL Power Calculations:** A-scan ultrasonography was used to measure the Axial length of the eye. SRK II formula was used for IOL power calculation.
viii. **Fundus Examination:** The Fundus of the eye was examined using Slit Lamp Biomicroscope with 90D and Indirect Ophthalmoscope with 20D lens.

For the investigative phase, a series of laboratory tests and assessments were performed to evaluate the general health status of the participants:

i. Fasting Blood Sugar (FBS) and Random Blood Sugar (RBS): Blood samples were collected to measure fasting and random blood sugar levels.
ii. Blood Pressure Measurement: Blood pressure was recorded to evaluate the cardiovascular health of the participants.
iii. HIV Testing: Participants were tested for the presence of the Human Immunodeficiency Virus (HIV).
iv. Hepatitis B Surface Antigen (HBsAg) Testing: The presence of HBsAg, a marker of hepatitis B infection, was assessed.

### Anesthesia

After cleaning the eyelid with 5% Betadine solution,

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peribulbar Injection was given with 2% lignocaine + 0.5% bupivacaine + 1500 units of hyaluronidase, following aseptic precaution.

**Surgical Steps**

**Group A underwent SICS**. Proper painting & draping was done. Superior rectus bridle suture was applied. The incision site was taken superior; a 7-8 mm fornix based conjunctival flap was made to expose the sclera and bleeding vessels were cauterized by wet field thermal bipolar cautery. 6.5 mm Frown Incision were made at a distance of 2 mm from the limbus with 15 no blade. Self-sealing tunneling done. Anterior chamber was entered using a 2.8 mm keratome. Dye, BSS, and Viscoelastic substance injected. Side ports are made. After maintaining the anterior chamber, capsulorrhexis was done. Hydro dissection was done. Nucleus was dialed in the anterior chamber and delivered by Hydro Expression. Irrigation and aspiration done. A non- foldable posterior chamber PMMA IOL implanted within the bag. Anterior chamber thorough irrigation and aspiration done to remove the viscoelastic substance. Re-apposition of conjunctival flap done. Subconjunctival antibiotic and steroid injected. Eye padded and bandaged.

**Group B underwent Phacoemulsification**. Proper painting & draping was done. The incision site was taken temporally. Side ports are made with MVR blades. Air, adrenaline, dye, BSS, and viscoelastic substances are injected. Cystitome introduced through one of the side ports and capsulorrhexis done. A clear corneal 2.8 mm incision is made temporally. Hydro delineation and hydro dissection done. Nucleus was emulsified by stop and chopping technique. Thorough irrigation and aspiration done. A Foldable posterior chamber IOL put in the capsular bag. PCIOL dialed in the posterior chamber. Irrigation and aspiration done to remove the viscoelastic substance. Side port was hydrated. Check patency of the anterior chamber. Subconjunctival antibiotic and steroid injected. Eye padded and bandaged.

**Postoperative Care**

All Patients were given a tab. Ciprofloxacin 500 mg twice daily along with anti-inflammatory drug and multivitamin for 5 days.

Antibiotic and steroid combination eye-drops were given in weekly tapering doses as 6 times/day to 1 times/day till 45 days.

**Measurement of Surgically Induced Astigmatism (SIA) Calculation**

Surgically induced astigmatism was calculated to evaluate the changes in astigmatism resulting from the surgical procedure. Measuring Surgically Induced Astigmatism(SIA) involves using SIA formula and specialized tools designed for this purpose. SIA was calculated using the SIA calculator version 2.1 to analyze keratometry data to determine the surgically induced astigmatism (SIA).

- Input Preoperative Data: Entering the preoperative Keratometry into the calculator.
- Input Postoperative Data: Entering the postoperative keratometry into calculator.
- Calculate the SIA: The Surgically Induced Astigmatism is calculated and displayed automatically. This value represents the change in astigmatism induced by the surgical procedure.
- Interpret the Results: A positive value indicates that astigmatism has increased, while a negative value indicates a reduction in astigmatism.

**Follow up**

All the cases were followed up on the 1 day, 1 weeks, 6 weeks, 12 weeks' postoperative day. At each visit, measurement of visual acuity, keratometry, anterior segment examination, & fundus examination, were done.

At the end of 12 weeks Surgically Induced Astigmatism (SIA), was determined. The best corrected visual acuity and various complications were noted. SIA Calculator Version 2.1 has been designed to calculate Surgically induced astigmatism. At the end of the study, all participants were thanked for their participation. They were also handed a certificate for their participation in the present study.

**Statistical Analysis Plan**

The primary outcome was the SIA at the last follow-ups. Secondary outcomes were the changes in the overall visual acuity and complications. We aimed to assess whether data supplied evidence of the significant difference in SIA among the patients who underwent SICS and Phacoemulsification for unilateral uncomplicated cataracts. The primary data were collected in a paper-based form. Thereafter, the coded data were entered in Microsoft Excel. The coded data were imported into Stata 17.1 version for analysis. For the continuous variables, the author calculated the mean, median, mode and standard deviation. For discrete variables, the author calculated and reported frequency, proportion, and percentage. A comparison of continuous variables with baseline values was analyzed using a student's t-test in each group. Categorical variables were analyzed using chi-square (x2). We followed the scientific convection for detecting a significant difference between two groups of P-value<0.05

**RESULTS**

**Demographic Profile:** The demographic profile of both the groups were highlighted in Table 1.

We observed that the distribution was not significant amongst both the groups.

DOI: 10.69605/ijlbpr_13.11.2024.141

| Variable | SICS group | Phaco Group | Total | P value |
|---|---|---|---|---|
| **Age** | 61.6±6.32 | 61.5±6.61 | | **0.165** |
| **Gender** | | | | |
| Male | 27(54%) | 18 (36%) | 45 (45%) | |
| Female | 23 (46%) | 32 (64%) | 55(55%) | 0.704 |
| **Eye involved** | | | | |
| Left | 21(42%) | 26(52%) | 47 (47%) | 0.0612 |
| Right | 29(58%) | 24(48%) | 53 (53%) | |

**Visual Acuity (VA)**

In majority of the patients, the 12 weeks' postoperative visual acuity (VA) of 6/9-6/12was observed in twenty-eight patients of SICS group (56 %) and in Phaco group it was present in thirty-three patients (66%). VA of 6/18 was observed in twenty patients of SICS group (40%), while in Phaco group it was observed in seventeen patients (34%). We observed no significance difference in the distribution of postoperative VA amongst both the groups (p=0.672)

| **Uncorrected Visual Acuity (VA) in both the groups** | | | |
|---|---|---|---|
| **Pre-Operative Visual Acuity** | **SICS group** | **Phaco group** | **P value Chi square test** |
| 1/60-2/60 | 16 (32%) | 13 (26%) | |
| 3/60-5/60 | 18 (36%) | 20 (40%) | 0.458 |
| 6/60-6/36 | 16 (32%) | 17 (34%) | |
| **Post-operative Visual Acuity** | | | |
| 6/9-6/12 | 28 (56%) | 33 (66%) | |
| 6/18 | 20 (40%) | 17 (34%) | 0.672 |
| 6/24 | 2 (4%) | 0 | |

**BCVA**

In majority of the patients, the 12 weeks postoperative best corrected visual acuity (BCVA)of 6/6 was observed in twenty-four patients of SICS group (48 %) and in Phaco group it was present in twenty-seven patients (54%). BCVA of 6/9 was observed in twenty-two patients of each SICS group (44%) and Phaco group. We observed no significance difference in the distribution of postoperative BCVA amongst both the groups (p=0.598)

| **BCVA in both the groups** | | | |
|---|---|---|---|
| **Pre-Operative BCVA** | **SICS group** | **Phaco Group** | **P value Fisher's exact test** |
| 1/60-2/60 | 0 | 3 (6%) | |
| 3/60-5/60 | 21(42%) | 23(46%) | 0.651 |
| 6/60-6/24 | 29(58%) | 24(48%) | |
| **Post-Operative BCVA** | | | |
| 6/6 | 24(48%) | 27(54%) | |
| 6/9 | 22(44%) | 22(44%) | 0.598 |
| 6/12 | 4(8%) | 1(2%) | |

**Keratometry readings in vertical (KV) and horizontal (KH) meridian pre-operatively and post-operatively**

Preoperatively, we have not observed any significant difference in the mean Kh and Kv values of both the groups. (p=0.129 and p=0.174 respectively).

At, Day1, Week1, week 6 and week 12 postoperatively, we have not observed any significant difference in the mean Kh and Kv values of both the groups. (p>0.05).

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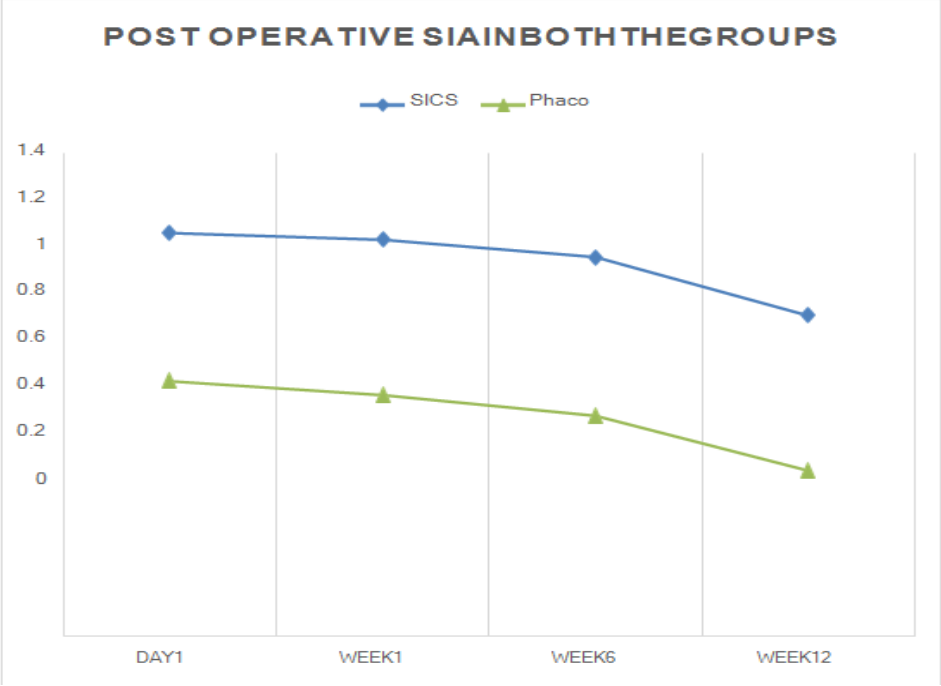
| Keratometry readings in vertical (KV) and horizontal (KH) meridianpre-operatively and post-operatively | | | |
|---|---|---|---|
| | | **Kh** | **Kv** |
| Pre op | Phaco | 44.28±1.33 | 44.29±1.25 |
| | SICS | 44.24±1.30 | 44.64±1.28 |
| | **P value** | **0.129** | **0.174** |
| Day1 | Phaco | 43.95±1.26 | 44.46±1.29 |
| | SICS | 44.62±1.20 | 44.08±1.23 |
| | **P value** | **0.16** | **0.19** |
| Week1 | Phaco | 43.99±1.17 | 44.41±1.19 |
| | SICS | 44.19±1.16 | 44.55±1.14 |
| | **P value** | **0.25** | **0.34** |
| Week6 | Phaco | 44.18±1.11 | 44.14±1.10 |
| | SICS | 44.22±1.13 | 44.47±1.09 |
| | **P value** | **0.19** | **0.18** |
| Week 12 | Phaco | 44.14±1.09 | 44.15±1.11 |
| | SICS | 44.25±1.07 | 44.40±1.08 |
| | **P value** | **0.17** | **0.24** |

**Preoperative Astigmatism**

The preoperative astigmatism in the SICS group was1.20±0.47 and 1.01±0.51 in the Phaco group. (p=0.065)

**Postoperative SIA**

At Day1(1.20±0.47 v/s 1.01±0.51), week1 (1.17±0.17 v/s 0.74±0.10)
week 6 (1.15±0.65 v/s 0.70±0.09) and week 12 (0.93±0.28 v/s 0.48±0.14), the SIA was significantly less in Phaco group as compared to SICS group (p<0.001)




**Type of astigmatism**

In the preoperative period, the majority of the patients in the SICS group had the rule (WTR) type of astigmatism (35%), in the Phaco group also, the majority of the patients had WTR type of astigmatism (32%).

| Type of astigmatism in both the groups | | | | |
|---|---|---|---|---|
| **Pre-operative** | **SICS group** | **Phaco Group** | **Total** | **P value Chi Square test** |
| WTR | 35(35%) | 32(32%) | 67(67%) | 0.0412* |
| ATR | 15(15%) | 18(18%) | 33(33%) | |

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**Postoperative astigmatism**

At 12 weeks' post-operative period. WTR type was increased in SICS group (32%) while it decreased in Phaco group (28%). On comparing the two groups, there was a statistically significant difference between the preoperative (p =0.0412) and 12 weeks postoperative (p=0.0368) type of astigmatism.

| Postoperative type of astigmatism in both the groups | | | | |
|---|---|---|---|---|
| **12 weeks Postoperative** | **SICS group** | **Phaco Group** | **Total** | **P value Chi square test** |
| WTR | 32 (32%) | 28 (28%) | 60 (60%) | 0.0368 |
| ATR | 18 (18%) | 22 (22%) | 40 (40%) | |

**Complications**

It was observed that 25 patients (50%) in SICS group had complications like Aqueous chamber inflammatory reaction (8%); Corneal edema (28%); Descemet fold (6%), Hyphema (6%) and Striate keratopathy (2%) at day 1 postoperative., while in Phaco group only 18% patients had day 1 postoperative complications, corneal edema (6%), Descemet fold (4%) and striate keratopathy (4%)

We observed a significant difference in the distribution of day 1 postoperative complications amongst both the groups (p = 0.001) No complications were observed after 90 days postoperative in either of the groups.

| Postoperative complications in both the groups | | | |
|---|---|---|---|
| **Day1** | **SICS (N=50)** | **Phaco (N=50)** | **P value Chi square test** |
| Corneal Oedema | 14 (28%) | 3 (6%) | 0.001* |
| Striate keratopathy | 1 (2%) | 4 (4%) | |
| Descemet fold | 3 (6%) | 2 (4%) | |
| AC Inflammatory Reaction | 4 (8%) | | |
| Hyphema | 3 (6%) | | |
| **None** | **25 (50%)** | **41 (82%)** | |
| Day 90 | None | None | |

**DISCUSSION**

Following cataract surgery, patients anticipate having clear vision and requiring less glasses. This objective requires SIA to be lowered. The goal of contemporary cataract surgery is this alteration. The limited data on SIA following 2.8 mm temporal clear corneal Phacoemulsification surgery compared to 6.5mm superior corneoscleral incision cataract surgery served as the impetus for this study.

The primary goal of this study was SIA; we also compared the groups in terms of age, sex, and the laterality of the operated eyes. None of them was statistically significant. Using keratometry readings, astigmatism was evaluated, and the SIA Version 2.1 calculator was used to compute SIA. The degree of incision is a significant determinant in the astigmatism that is created.

We compared just two sizes of incisions: 6.5 mm for the manual SICS group and 2.8 mm for the Phacoemulsification group. Compared to the bigger incisions needed for the rigid lens implantation, we discovered that the smaller incision produced substantially superior outcomes in terms of wound closure, integrity, and induced astigmatism. Several studies have shown that smaller incisions result in less astigmatism and stabilize more quickly than bigger incisions. [12-17]

Preoperative astigmatism in the SICS group in the current study was 1.20±0.47, whereas in the Phaco group it was 1.01±0.51. At Day 1 (1. 20 ± 0.47 v/s 1.01 ± 0.51), Week 1 (1.17 ± 0.17 v/s 0.74 ± 0.10), Week 6 (1.15 ± 0.65 v/s 0.70 ± 0.09), and Week 12 (0.93 ± 0.28 v/s 0.48 ± 0.14), the SIA was significantly lower in the Phaco group compared to the SICS group (p<0.001). During the preoperative phase, the majority of patients in the SICS group and the Phaco group, respectively, had 35% and 32% of WTR type astigmatism. Twelve weeks following surgery, WTR type fell in the SICS group (32%) and also fell in the Phaco group (28%). In the first and last follow-up, the Phacoemulsification group outperformed the SICS group in terms of non-significant visual outcomes, according to our study. In the current study, it was found that on day 1 postoperatively, 25 patients (or 50%) in the SICS group experienced complications such as aqueous

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chamber inflammatory reaction (8%) corneal edema (28%) Descemet fold (6%) Hyphema (6%) and striate keratopathy (2%) whereas only 18% of patients in the Phaco group experienced these same complications.

## CONCLUSION

The findings of our study lead us to the conclusion that, in comparison to small incision cataract surgery, phacoemulsification results in better visual outcomes and less surgically induced astigmatism. Even if SICS is a less expensive option than phacoemulsification, those who can afford it and who need the best and earliest visual result should be offered the Phacoemulsification option.

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