Comparative Study of Surgically Induced Astigmatism in Different Types of Cataract Incision

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ABSTRACT:

Background: Cataract remains the leading cause of blindness in India. Advances in cataract surgery have transformed it from a purely vision-restoring procedure into a refractive surgery, with a major determinant of postoperative success being surgically induced astigmatism (SIA).

Aim: To evaluate the incidence and pattern of post-surgical astigmatism in relation to three types of incisions: superior sclero-corneal valve incision (SSC) in manual small incision cataract surgery, and superior (SCC) and temporal clear corneal valve incisions (TCC) in phacoemulsification surgery.

Methods: A comparative study was conducted on 120 patients undergoing cataract surgery, divided equally into three groups (SSC, SCC, TCC). Keratometry readings were recorded preoperatively and postoperatively at 1, 3, and 6 weeks. Surgically induced astigmatism was analyzed across groups using statistical tests for significance.

Results: SSC and SCC incisions predominantly induced against-the-rule (ATR) astigmatism, whereas TCC incision more commonly resulted in with-the-rule (WTR) astigmatism. While superior incisions showed greater ATR shift, temporal incisions demonstrated earlier wound stability and lower mean postoperative astigmatism. Paired comparisons showed statistically significant changes in the TCC group at week 1 ($p<0.05$), while SSC showed highly significant differences in the horizontal meridian.

Conclusion: Temporal clear corneal incisions induce lower and more favorable astigmatism compared to superior approaches, making them advantageous for patients with pre-existing ATR astigmatism. Superior incisions, however, may be beneficial in cases of WTR astigmatism. Individualized incision planning is therefore essential to optimize visual outcomes.

KEYWORDS

Cataract surgery; Surgically induced astigmatism; Phacoemulsification; Manual small incision cataract surgery (MSICS); Clear corneal incision; Sclero-corneal incision; Keratometry.

INTRODUCTION

Cataract is the leading cause of blindness in India, responsible for 50–80% of bilateral blindness. With advances in surgical techniques, cataract surgery has evolved from a vision-restoring procedure to a refractive one, where postoperative success depends largely on controlling surgically induced astigmatism (SIA).

Astigmatism, caused by irregular corneal or lenticular curvature, can reduce visual acuity and increase spectacle dependence after surgery. Even more than 0.75 D of corneal astigmatism is seen in nearly 60% of cataract patients. The type, site, and size of incision play a critical role in the magnitude and type of SIA.

Modern techniques—from intracapsular cataract extraction to extracapsular, MSICS, and phacoemulsification—have progressively reduced astigmatic outcomes. Among them, clear corneal incisions and toric IOLs further improve refractive predictability.

This study evaluates postoperative astigmatism associated with three incision types: superior sclero-corneal (SSC), superior clear corneal (SCC), and temporal clear corneal (TCC), to identify the most favorable approach for minimizing astigmatism and optimizing visual outcomes.

AIMS AND OBJECTIVES

AIM OF THE STUDY:

This study aims to evaluate the incidence of post-surgical astigmatism in relation to three types of incisions; that of sclero-corneal valve incision in manual small incision cataract surgery and clear corneal valve incisions (superior and temporal) in phacoemulsification surgery.

CLINICAL OBJECTIVES:

To assess the incidence of post-surgical astigmatism with respect to two categories of superior incisions; that of sclero-corneal valve incision in manual small incision cataract surgery and clear corneal valve incision in phacoemulsification surgery.

To correlate the post-surgical astigmatism in the two groups given above.

To assess the incidence of post-surgical astigmatism with respect to two location of clear corneal valve incisions in phacoemulsification; that of superior and temporal.

To correlate the post-surgical astigmatism in the two groups given above.

MATERIALS AND METHODS

SOURCE OF THE DATA

The patients presenting at the ophthalmology department, who underwent Manual Small Incision Cataract Surgery or Phacoemulsification with PCIOL implantation in one eye.

Approval for the study protocol and clearance was procured from the ethical review committee of the institute to which the hospital, where the study was conducted, are affiliated.

Patients were taken in the study on the basis of the inclusion and exclusion criteria.

Informed consent will be obtained after informing the study subjects regarding the details of the procedure. Only after obtaining the consent from the subjects, the individual will be included in the study.

METHODS OF COLLECTION OF DATA

Study type: Comparative study.

Duration of study: Eighteen months.

Sample Size: One hundred and twenty patients (selected using purposive sampling technique), who underwent either Phacoemulsification or Manual Small Incision Cataract Surgery with PCIOL implantation in one eye were included in the study. Data was compiled with the help of a proforma. These one hundred and twenty patients were divided as follows:

Group A: 40 Manual Small Incision Cataract Surgery with Superior Sclero-Corneal valve incision. (S.S.C.)

Group B: 40 Phacoemulsification with Superior Clear Corneal valve incision. (S.C.C.)

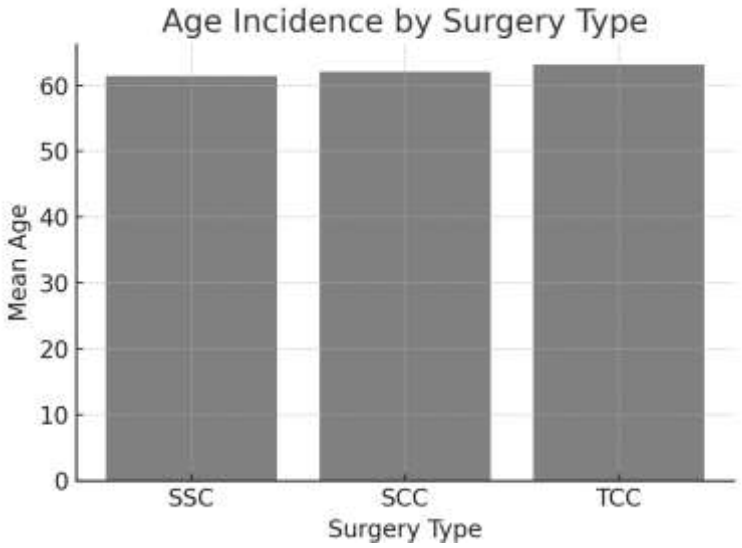
Group C: 40 Phacoemulsification with Temporal Clear Corneal valve incision. (T.C.C.)

Patients were allocated to either Group A or Group B/ Group C on the basis of the grade of cataract.

RESULT

Table 1: Age Incidence

Type of Surgery	N	Mean Age	Std Deviation	Minimum	Maximum
SSC	40	61.5	7.328	45	70
SCC	40	62.1	5.66	50	70
TCC	40	63.15	5.531	50	70



Group	Male (n)	Male (%)	Female (n)	Female (%)	Total
SSC	22	55.0%	18	45.0%	40
SCC	22	55.0%	18	45.0%	40
TCC	19	47.5%	21	52.5%	40
Total	63	52.5%	57	47.5%	120

Table 2: Gender Distribution

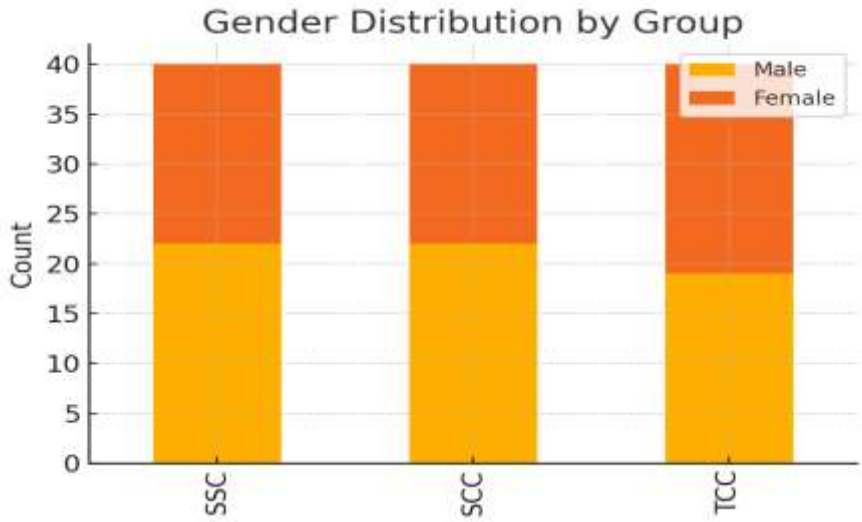


Table 3: Surgically Induced Astigmatism

Group	A0 Mean	A1 Mean	A3 Mean	A6 Mean
SSC	0.5	1.175	1.0625	1.1562
SCC	0.4875	1.1812	1.1375	1.1375
TCC	0.7188	0.7688	0.6938	0.6312

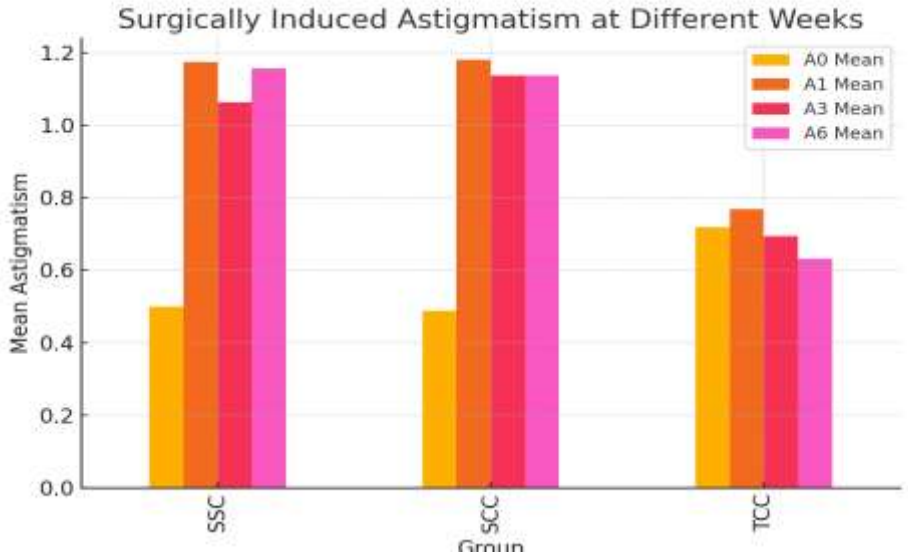


Table 4: Vertical Corneal Meridian Keratometry

Group	Pre-op Kv	Post-op Kv (1W)	Post-op Kv (3W)	Post-op Kv (6W)
SSC	43.675	43.8562	43.7312	43.587
SCC	44.2125	44.125	44.2688	44.2125
TCC	44.3875	44.5688	44.4688	44.4

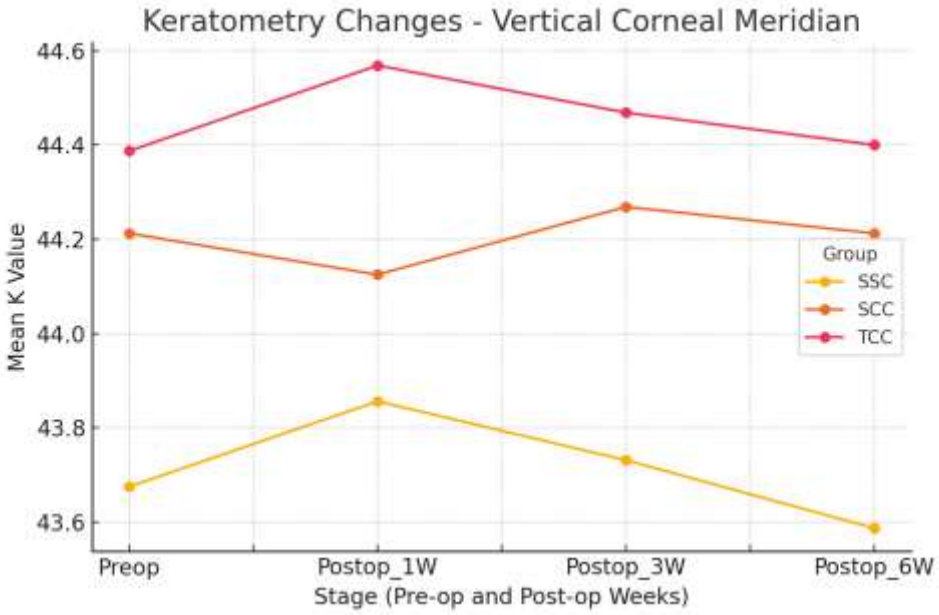


Table 5: Horizontal Corneal Meridian Keratometry

Group	Pre-op Kh	Post-op Kh (1W)	Post-op Kh (3W)	Post-op Kh (6W)
SSC	43.7688	44.4438	44.3562	44.2688
SCC	44.4125	44.5938	44.7312	44.7375
TCC	44.1062	43.8562	43.9875	43.9562

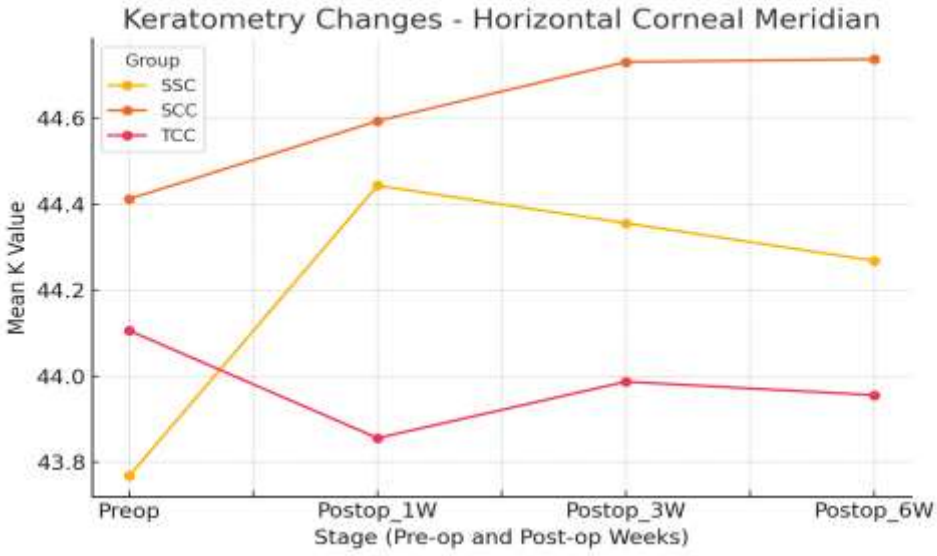


Table 6: Paired Differences – Vertical Corneal Meridian

Group	Comparison	Mean Diff	t	P value	P num
SSC	Pre-op vs Post-op Kv (1W)	-0.18125	-0.908	0.369	0.369
SSC	Pre-op vs Post-op Kv (3W)	-0.05625	-0.321	0.75	0.75
SSC	Pre-op vs Post-op Kv (6W)	-0.088	0.512	0.611	0.611
SCC	Pre-op vs Post-op Kv (1W)	0.0875	0.558	0.58	0.58
SCC	Pre-op vs Post-op Kv (3W)	-0.0563	-0.325	0.747	0.747
SCC	Pre-op vs Post-op Kv (6W)	0.0	0.0	1.0	1.0
TCC	Pre-op vs Post-op Kv (1W)	-0.1813	-2.159	0.037	0.037
TCC	Pre-op vs Post-op Kv (3W)	-0.0813	-1.106	0.276	0.276
TCC	Pre-op vs Post-op Kv (6W)	-0.0125	-0.162	0.872	0.872

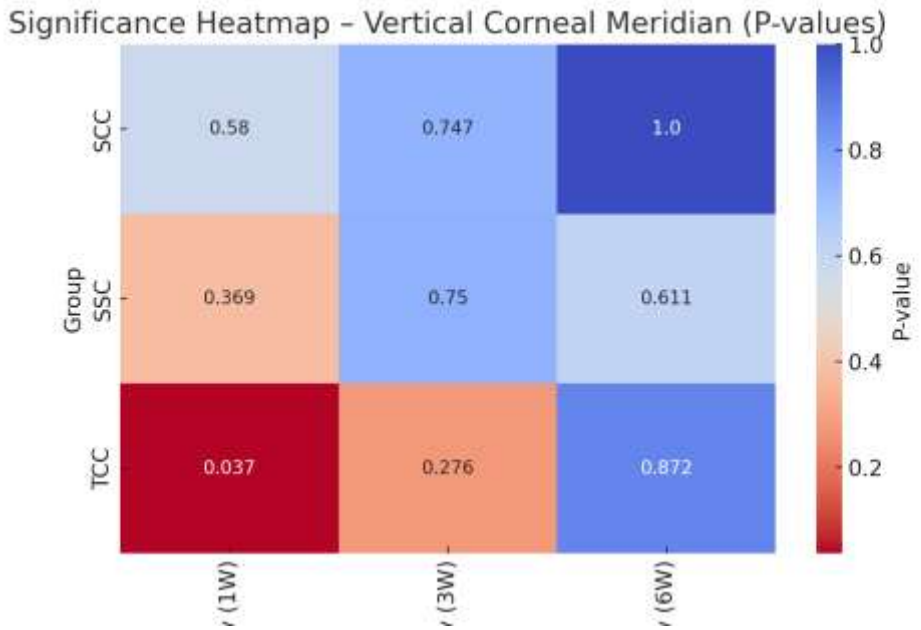
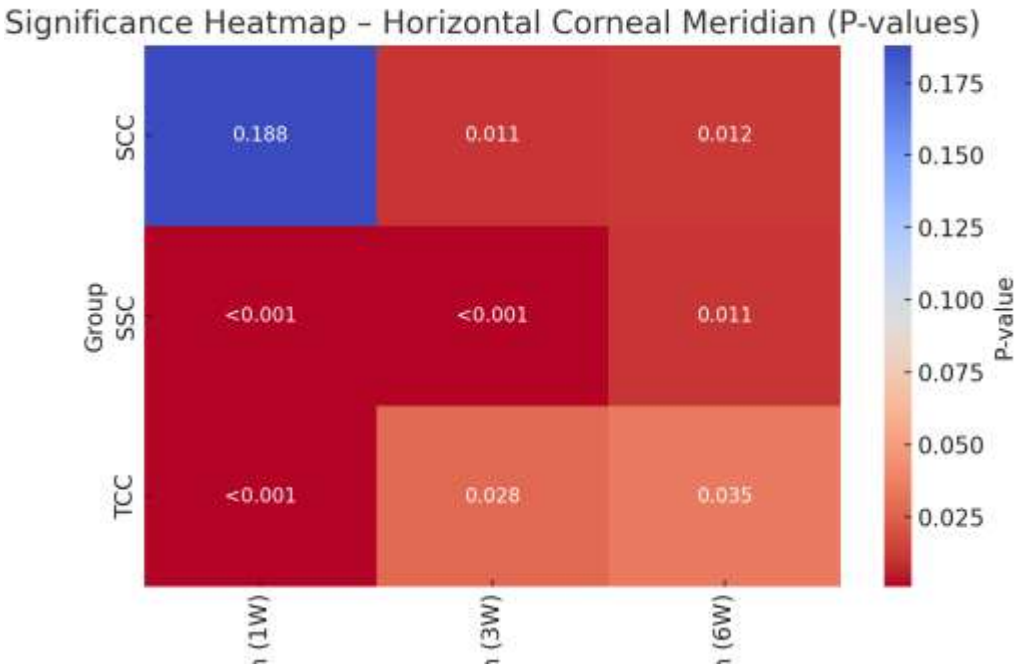


Table 7: Paired Differences – Horizontal Corneal Meridian

Group	Comparison	Mean Diff	t	P value	P num
SSC	Pre-op vs Post-op Kh (1W)	-0.675	-4.207	<0.001	0.001
SSC	Pre-op vs Post-op Kh (3W)	-0.5875	-3.672	<0.001	0.001
SSC	Pre-op vs Post-op Kh (6W)	-0.5	-2.657	0.011	0.011
SCC	Pre-op vs Post-op Kh (1W)	-0.1813	1.341	0.188	0.188
SCC	Pre-op vs Post-op Kh (3W)	-0.3188	-2.662	0.011	0.011
SCC	Pre-op vs Post-op Kh (6W)	0.325	-2.633	0.012	0.012
TCC	Pre-op vs Post-op Kh (1W)	0.25	4.21	<0.001	0.001
TCC	Pre-op vs Post-op Kh (3W)	0.1188	2.276	0.028	0.028
TCC	Pre-op vs Post-op Kh (6W)	0.15	2.185	0.035	0.035



FIGURES:

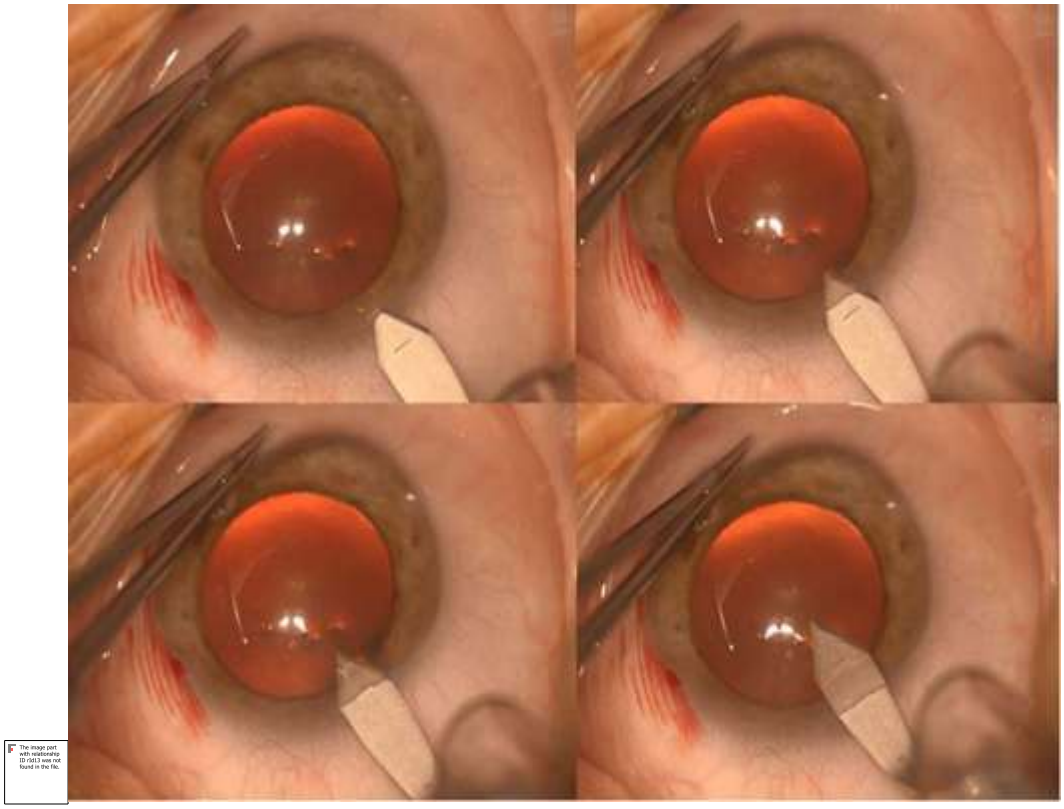


FIG 01:Clear corneal Incision

Fig 02:Sclero - corneal incision

Discussion

Cataract remains a significant public health problem and the leading cause of blindness worldwide. While phacoemulsification is considered the gold standard, manual small incision cataract surgery (MSICS) continues to be widely used in developing countries. One of the main challenges in cataract surgery is surgically induced astigmatism (SIA). The present study evaluates and compares the astigmatic outcomes of superior sclero-corneal, superior clear corneal, and temporal clear corneal incisions.

Our findings highlight that superior incisions tend to induce higher against-the-rule (ATR) astigmatism, while temporal clear corneal incisions more commonly induce with-the-rule (WTR) astigmatism. The temporal approach demonstrated earlier wound stability, making it advantageous in terms of faster rehabilitation and less postoperative astigmatism.

The decay of mean astigmatism showed that both superior and temporal incisions resulted in a postoperative change, but the magnitude of ATR shift was greater in the superior incisions. Previous studies (Jaffe, Duke-Elder, Bhasker et al., George et al., Simsek et al.) corroborate these findings, supporting that temporal clear corneal incisions result in less SIA.

The clinical implication of these results is that temporal clear corneal valve incision is a preferred technique for patients with pre-existing ATR astigmatism, while superior approaches may be considered in WTR cases. Additionally, the size, shape, and location of the incision play a crucial role in determining postoperative astigmatism. Chevron-shaped incisions and smaller incision sizes (≤6 mm) have shown to induce less SIA.

This study reaffirms the importance of individualized incision planning in cataract surgery. Clear corneal incisions provide better visualization, quicker surgery, less bleeding, and self-sealing wounds, making them suitable for modern cataract procedures, especially with foldable IOLs.

CONCLUSION

• There is no significant difference in the surgically induced astigmatism caused by the superior sclero-corneal tunnel (S.S.C.) in manual small incision cataract surgery and the superior clear corneal tunnel (S.C.C.) in phacoemulsification.

• In phacoemulsification surgery, the temporal clear corneal tunnel (T.C.C.) induces significantly lower astigmatism than the superior clear corneal tunnel (S.C.C.).

• As compared to the S.S.C. incision, the S.C.C. incision showed a slightly lower post-operative ATR drift. Therefore, both incisions are suitable for patients with pre-operative WTR astigmatism.

• As compared to the S.C.C. incision, the T.C.C. incision showed a higher post-operative WTR drift. Thus, the T.C.C. incision is favoured for patients with pre-operative ATR astigmatism.

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