

ORIGINAL ARTICLE

EFFECT OF SUPEROTEMPORAL CLEAR CORNEAL INCISION ON PRE-EXISTING ASTIGMATISM AFTER PHACOEMULSIFICATION SURGERY

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Background: Historically, patients undergoing cataract surgery were at an increased risk of developing surgically induced astigmatism with the advent of modern methods of cataract surgery, the focus shifted towards smaller sized incisions and minimally invasive surgery. Smaller incision produces less post-operative change in astigmatism and early visual rehabilitation as compared to larger incisions. This study was conducted to evaluate and compare the difference between pre and post op corneal astigmatism among patients undergoing phacoemulsification surgery, for cataract, via a superotemporal clear corneal incision. **Methods:** This was a longitudinal study that enrolled 85 patients between the ages of 40 and 90 years at Ophthalmology Department, Jinnah International Hospital, Abbottabad. Patients were divided into 2 groups according to their pre existing astigmatism. Group A, With the Rule (WTR), astigmatism and Group B, Against the Rule (ATR) astigmatism. Astigmatism was measured and compared pre operatively, and on day 1, day 7 and day 30 post operatively via auto kerato-refractometer. **Results:** The mean astigmatism in patients in Group A (WTR astigmatism) preoperatively was 0.76 Diopters, whereas patients in Group B (ATR astigmatism) had a mean pre operative astigmatism of 0.68 Diopters. Mean astigmatism post operatively at day 30 was 0.86 Diopters for Group A, and 1.02 Diopters for Group B. Only 2 out of 36 patients in Group A had a shift to ATR astigmatism, whereas 4 out of 49 patients in Group B had a shift to WTR astigmatism by post op day 30. **Conclusion:** Superotemporal clear corneal incision is a relatively stable and effective site for incision during phacoemulsification surgery, and causes negligible change in pre operative astigmatism.

Keywords: Phacoemulsification; Astigmatism; With the rule; Against the rule; Superotemporal incision

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INTRODUCTION

Astigmatism is a refractive error, where light is refracted at different angles, forming a line focus instead of a single focal point. It is of various types, the most common being corneal astigmatism.¹ This is due to an abnormality in the corneal shape. Regular Astigmatism is further subdivided into three categories, With the Rule (WTR), Against the Rule (ATR) and Oblique Astigmatism.² In with the rule (WTR) astigmatism, the two principal meridians of the cornea are at 90 degrees to each other, where the vertical meridian is steeper than the horizontal meridian. In against the rule (ATR) astigmatism, the horizontal meridian is steeper, and requires a convex lens along this plane for correction.^{1,2} Oblique Astigmatism is classified as values in between the above mentioned meridians.² In young individuals, cornea is steepest in its vertical meridian (WTR

astigmatism). As a person gets older, there is a shift to ATR.³

Historically, patients undergoing cataract surgery were at an increased risk of developing surgically induced astigmatism as a result of older methods of surgery which had larger incisions.⁴ With the advent of modern methods of cataract surgery, the focus shifted towards smaller sized incisions and minimally invasive surgery. Literature also supports smaller sized incisions, in patients with pre-existing astigmatism, when undergoing cataract surgery as a smaller incision produces less post-operative change in astigmatism and early visual rehabilitation when compared with larger incisions.⁵⁻⁷

Phacoemulsification is a modern technique in cataract surgery aimed to achieve the best uncorrected visual acuity with minimal tissue damage.⁸ It involves creating a small incision into the clear cornea. An

ultrasound probe is used to emulsify and aspirate the cataractous lens.⁹ an artificial intra ocular lens is then implanted in its place. Phacoemulsification can be performed through different incisions, varying in size and location. The purpose of this is to reduce the total post operative astigmatism. They may be given superiorly (12'o clock), superotemporally, superonasally or temporally, depending on the patient's pre op astigmatism and surgeon preference.¹⁰

Phacoemulsification has been widely adopted as the standard for cataract surgery.¹¹ However, even with a smaller sized incision cataract surgery flattens the cornea locally in the meridian of the incision made. There is a large variation in the corneal flattening in individuals and therefore a poor post surgical astigmatism predictability.⁸ The site of the corneal incision for phacoemulsification thus adds a further variable,¹² as placing the incision more anteriorly causes more astigmatism as compared to a limbal based incision.¹³ Superior clear corneal incisions have the advantage that they are covered by the upper eyelid and have better wound sealing, but cause more surgically induced astigmatism (SIA) as compared to temporal incisions.¹⁴

Supero-temporal incision causes flattening of the horizontal axis of the cornea and also neutralizes the gravitational forces along with eyelid drag on the incision unlike made in superior incision.¹⁵ This causes a shift to WTR astigmatism and therefore this incision has an advantage in patients having ATR astigmatism which is common in older age group. Whereas superior scleral incision (SI) is advantageous in patients with with-the-rule (WTR) astigmatism present pre-operatively.¹⁵ Superotemporal corneal incision has the benefit that it provides long term stability, and causes a negligible change in pre op astigmatism.¹⁶ Superonasal corneal incisions are comparable to superotemporal corneal incisions in terms of surgically induced astigmatism, for a surgeon sitting at the 12'o clock position.¹⁷ All these various types of corneal incisions are similar in efficacy when it comes to post-operative visual rehabilitation.¹⁸

The purpose of this study was to assess the change in corneal contour after phacoemulsification surgery through a superotemporal clear corneal incision in patients with preexisting astigmatism, who belonged to a higher age group. This incision has shown a benefit in minimally invasive cataract surgery, however few studies have been done on phacoemulsification cataract surgery using a superotemporal incision, especially in Pakistan. Superotemporal incision was used for both right and left eyes as it provides superior visual outcomes¹⁹ and ease of access surgically. Phacoemulsification

is still new to developing countries and research needs to be done regarding the change in post-operative corneal contour via different incisions especially in the elderly population.

MATERIAL AND METHODS

This was a longitudinal study that enrolled 85 patients, between the ages of 40–90 years at Ophthalmology Department, Jinnah International Hospital, Abbottabad. These patients were enrolled between September 2022 and September 2023. Study participants were selected using non-probability consecutive sampling. Data collection was done after ethical approval from the hospital ethics committee. Informed consent was taken from all patients. Complete ophthalmological exam was done via slit lamp, pre and post operatively. Visual acuity was documented via Snellen's chart. The patients included in this study were above the age of 40 and had pre-existing corneal astigmatism (less than 2 Diopters). The patients were divided into two groups depending upon, "With the Rule" (Group A) or "Against the Rule" (Group B) astigmatism. WTR astigmatism was considered to be the one where the steep axis was at 90 degrees \pm 20 degrees, and in ATR astigmatism the steep meridian was at 180 degrees \pm 20 degrees. Astigmatism other than these was classified as oblique, and was not included in the study. Similarly, other exclusion criteria were prior ocular surface disease, refractive or any other eye surgery, corneal scarring and opacities, very high (>2 Diopters) or irregular preoperative astigmatism.

Intraocular lens calculations were performed using A-scan ultrasonography (Quantel Medical 11 MHz) for axial length measurements and keratometry using Topcon KR 800 digital auto kerato-refractometer. All the surgeries were performed under topical anesthesia by the same surgeon. In all the cases, the patients underwent cataract surgery by phacoemulsification through a 3.2 mm superotemporal clear corneal incision, for right eyes at 11'o clock and at 1'o clock position for left eyes using a 3.2 mm true cut keratome. A single side port was made at 2'o clock position in right eyes, and at 4'o clock position in left eyes. A continuous curvilinear capsulorhexis (CCC) was performed with capsulorhexis forceps. Phacoemulsification was performed using Oertli machine with 19 gauge 30 degree tip. All patients were implanted with single piece, foldable acrylic IOL with an optical diameter of 6.0 mm (total diameter of 13.0 mm), placed in the capsular bag.

All patients were treated postoperatively with Dexamethasone eye drops (0.1% w/v) two hourly for the first week and then six hourly, eight hourly and then twice a day over the three subsequent weeks.

Topical Moxifloxacin eye drops (0.5% w/v) were given 6 hourly for 2 weeks postoperatively. Tobramycin (3.0mg) and Dexamethasone (1.0mg) combination eye ointment was prescribed to be used at night for 2 weeks. Follow up for evaluation of astigmatism was performed on Topcon KR 800 auto kerato-refractometer on day 1, day 7 and day 30 after surgery. Astigmatism was calculated using the American Society of Cataract and Refractive Surgery (ASCRS) Cornea SIA Tool. Data was analyzed using IBM SPSS software. Mean change in astigmatism less than 0.5 diopters was considered insignificant clinically as it has limited to no effect on the vision.

RESULTS

There was a total of 85 patients included in this study according to the selection criteria of which, 48 (56.5%) were males and 37 (43.5%) were females. The total number of patients undergoing cataract surgery for right eye were 43 (50.6%), whereas, the number of patients undergoing cataract surgery for the left eye were 42 (49.4%). The mean age of the patients was 62.71±10.76 years as shown in Table 1. Table 2 depicts the mean pre and post-operative K1, K2, Astigmatism and axis of astigmatism. The mean K1 value was 43.80±1.52 diopters, whereas the 30-day post op value was 43.76±1.51 diopters (*p* value 0.544). The mean pre op K2 was 44.53±1.61 diopters, and the 30-day post op value was 44.71±1.50 diopters. This mean K2 change between pre op and 30 days post op was significant (*p* value: 0.009). Furthermore, there

was significant change (*p* value: 0.001) in mean pre-operative astigmatism 0.73±0.42, and the post op astigmatism on day 30 0.95±0.48. The difference in mean astigmatism was 0.22 Diopters. The *p* value was statistically significant however, clinically it was not significant as the mean change was under 0.5 diopters as defined previously.

Figure 1 gives a graphical representation of the mean change in astigmatism of the patients included in this study. The preoperative mean astigmatism was 0.73 Diopters. Postoperatively the on day 1 and day 7, the mean astigmatism increased to 1.05 Diopters and 1.08 Diopters respectively. On day 30 postoperatively the mean astigmatism decreased 0.95 Diopters.

The patients were distributed into two groups according to the corneal contour in table 3. Group A “With the Rule” Astigmatism had 36 patients with a mean preoperative astigmatism of 0.79 Diopters. Group B “Against the rule” Astigmatism patients were 49 with a preoperative mean of 0.68 Diopters (Table 3). Table 4 depicts that postoperatively, 4 patients showed a shift in corneal contour from Group B to Group A (mean 0.86 Diopters), whereas only 2 patients exhibited a corneal contour shift from Group A to Group B (mean 1.02 Diopters). The difference in mean astigmatism for Group A was 0.07 Diopters and for Group B was 0.34 Diopters and although, this mean change in Group B was statistically significant (*p* value <0.05) they were clinically insignificant as per our defined criteria (Table-3).

Table-1: Descriptive analysis of the study sample

Variable	Frequency (percentage)
Gender	
Male	48 (56.6%)
Female	37 (43.5%)
Side effected	
Right	43 (50.6%)
Left	42 (49.4%)
	Total: 85 (100%)

Table-2: Comparison of preoperative and 30 days post-operative ocular dimensions

Variable	Preoperative	1-month postop	<i>p</i> -value
K1	43.80±1.52	43.76±1.51	0.544
K2	44.53±1.61	44.71±1.50	0.009
Astigmatism	0.73±0.42	0.95±0.48	0.001

Table-3: Pre and 30 days postoperative state of astigmatism

	Preoperative astigmatism Mean (n)	30 days postoperative astigmatism Mean (n)	Difference	<i>p</i> -value
With the rule astigmatism (Group A)	0.79D (36)	0.86D (38)	0.07D	0.38
Against the rule astigmatism (Group B)	0.68D (49)	1.02D (47)	0.34D	0.00

Table-4: Details of changes in post-surgery astigmatism

	Unchanged (n)	Changed (ATR to WTR or WTR to ATR) (n)	Neutralized
With the rule astigmatism	34	2	0
Against the rule astigmatism	45	4	0

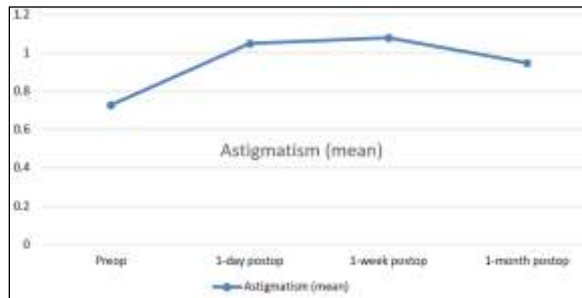


Figure-1: Mean Change in Astigmatism

DISCUSSION

Phacoemulsification is a modern technique in cataract surgery aimed to achieve the best uncorrected visual acuity with minimal tissue damage using a small sized incision.⁸ This surgical modality is aimed towards minimal change or even neutralizing pre existing corneal astigmatism by carefully planned incisions in specific meridians.²⁰ This study was undertaken to assess the change in corneal contour after phacoemulsification surgery through a superotemporal clear corneal incision in patients with preexisting astigmatism. The study showed that a superotemporal 3.2 mm incision for phacoemulsification surgery did not clinically cause any significant change in astigmatism as compared with the preoperative values although the change in mean values was statistically significant. The change was defined to be clinically insignificant if it was less than 0.5 Diopters and correlated with a comparable study done by S C Moon *et al.*,⁷ M. Shakaib Anwar¹⁶ and Nilesh Gautam *et al.*²⁰ The post operative mean showed an increase of 0.22 Diopters which was less than 0.5 Diopters. In quantifying the difference between WTR (Group A) and ATR (Group B) astigmatism, Group A had an overall difference of 0.07 Diopters and Group B had an increase of 0.34 Diopters which although statistically significant was within the defined clinical limit. M. Shakaib Anwar described an overall increase in mean astigmatism in both groups with WTR astigmatism mean increase of 0.27 Diopters and ATR astigmatism mean increase of 0.34 Diopters. Nilesh Gautam *et al.*²⁰ described a mean increase in WTR astigmatism of 0.31 Diopters and a mean increase in ATR astigmatism of 0.44 Diopters, the results of our study correlated with the results of the above mentioned studies.

The overall mean astigmatism showed an increase initially post operatively however, at 30th day post op the astigmatism showed a downward trend. Another study by Ryo Suzuki *et al.*²¹ shows there was no difference in power of astigmatism 3 months after phacoemulsification. One similar study by Yongqi He *et al.*²² showed a comparison was undertaken between

a temporal corneal incision and a superior scleral incision for patients undergoing phacoemulsification and the postoperative keratometric analysis was done between the two incisions. The temporal incision did not increase the corneal astigmatism more than the supero-scleral at three months postoperatively.

In our study, the total number of patients with WTR astigmatism was 36, whereas 49 patients had ATR. The majority of the patients had ATR, consistent with a study by Zhizhong Wu *et al.*²³ which showed a positive correlation of ATR with advancing age. Out of the 36 patients with WTR astigmatism, 2 patients had a shift towards ATR, whereas 4 out of the 49 patients with ATR astigmatism had a shift towards WTR astigmatism. This negligible shift overtime is consistent with a study done by Franco Mercieca *et al.*²⁴

Limitation

A limitation of the study was that it did not follow up the patients beyond 30 days. Further follow up is necessary to assess the further change in astigmatism and ascertain corneal stability, as evident by the research conducted by Ken Hayashi *et al.*²⁵

CONCLUSION

Superotemporal clear corneal incision is a relatively stable and effective site for incision during phacoemulsification surgery, as compared with other corneal incisions, and causes negligible change in post-operative astigmatism. A long term follow-up however is necessary to assess continued corneal stability.

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