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A STUDY ON SURGICALLY INDUCED ASTIGMATISM FOLLOWING SMALL INCISION CATARACT SURGERY

***Vinay KV¹, Sudheendra AN², Vishal K³ and Beena DN⁴**

^{1,3} Department of Anatomy, K. S. Hegde Medical Academy, Mangalore, Karnataka, India

² Department of Ophthalmology, Kasturba Medical College, Mangalore, Karnataka, India

⁴ Department of Anatomy, Kannur Medical College, Kannur, Kerala, India

**Author for Correspondence*

ABSTRACT

Corneal astigmatism has been a byproduct of cataract surgery since the first limbal incision was put. Cataract surgery incisions have been known for more than a century to influence astigmatism. A major factor responsible for post-operative astigmatism is the site of incision applied for cataract surgery. This study was done to determine if changes at the site of incision in cataract surgery might reduce the total astigmatism.

The present study was conducted on 96 patients who underwent suture less small incision cataract surgery (SICS) for a period of 2 years between April 2010 to April 2012 at Kasturba Medical College Hospital, Mangalore and Karnataka. A thorough pre-operative evaluation of the cases was done including pre-operative keratometry, slit lamp biomicroscopy and a scan. The patients were randomly divided into two groups, one group undergoing manual SICS with superior incision and the other group with super temporal incision. The astigmatic profile produced by superior scleral incision and super temporal scleral incisions, its decay over a period of 6 weeks and the post-operative astigmatic profile in patients having pre-operative against the rule astigmatism were studied.

The course of post-operative astigmatism changes were determined by keratometry. All changes of keratometry were recorded, tabulated for each corresponding period and the astigmatism decay for the two types of incisions were calculated using statistically acceptable method. The Z- test was applied to find out the significant differences between the two types of incisions.

On comparing the surgically induced astigmatism (SIA) between superior and super temporal incision types in SICS, it was found that SIA is statistically less in super temporal type. The decay of astigmatism from 3rd to 6th week in super temporal incision is statistically insignificant, implying early wound stabilization and therefore early spectacle correction in super temporal incision type than in superior incision. Thus, a simple change in the site of incision for cataract surgery can be helpful for patients in early wound stabilization and better patient compliance.

Key Words: *Astigmatism and Cataract Surgery*

INTRODUCTION

Cataract surgery incisions have been known for more than a century to influence astigmatism. Significant astigmatism may be visually disabling causing diminution in visual acuity, glare, monocular diplopia, asthenopia and distortion. A number of procedures have been developed to minimize and stabilize surgically induced astigmatism (SIA). Manual small incision cataract surgery (SICS) is one of the most innovative and popular technique (Ernest *et al.*, 1990). The use of small cataract incisions is thought to reduce SIA resulting in more stable refraction (Shepherd, 1989). The surgical techniques are being continuously modified and improved upon to decrease SIA. There are many factors responsible for SIA such as the location and type of cataract incision, size, configuration of wound, suture material used technique of wound closure etc. Among these, a major factor responsible for post-operative astigmatism is the location of cataract incision (Ken and Fuminoroi, 1994). The flattening of the cornea occurs at direction right angles to direction of cataract incisions (Axt and Mc Caffery, 1993). Therefore, placing the incisions on the steep meridian of pre-existing astigmatism can reduce post-operative astigmatism. It has

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been observed that farther the cataract incision from the visual axis, less is the effect on corneal curvature at visual axis. It has been reported that a lateral (Cravy, 1991) or a superolateral (Kawano and Umera, 1990) incision can decrease and quickly stabilize SIA (Ken and Fuminoroi, 1994). These two locations are farther from visual axis and flattening of cornea by the wound is less likely to affect the corneal curvature at visual axis, thus less astigmatism (Cravy, 1991). It has been found by keratometric measurement that the degree of SIA was significantly less in super lateral incision compared to superior incision and the variability of astigmatism was also less (Ken and Fuminoroi, 1994). In our study, we have made an effort to analyze the difference in magnitude of SIA between a superior and a super temporal incision in manual SICS.

MATERIALS AND METHODS

The present prospective study was done on 96 patients (47 males and 49 females) who underwent suture less SICS, between April 2010 to April 2012 at Kasturba Medical college Hospital, Mangalore, Karnataka. All patients with senile cataract were included in the present study. Patients with corneal degenerations, dystrophies, traumatic cataract and patients with pre-operative oblique astigmatism were excluded from the study. The majority of the patients who underwent surgery were in the age group of 50 to 60 years. A thorough pre-operative evaluation of the cases including pre-operative keratometry, slit lamp examination and A-scan were done. The patients were randomly divided into two groups, one group undergoing manual SICS with superior incision and the other group undergoing manual SICS with super temporal incision. Out of 96 patients, the superior incision was put in 52 patients (54.17%) & super temporal incision in 44 patients (45.83%).

In superior sclera incision type, a sclera incision of 6.5mm was fashioned 3mm behind the limbus in superior sclera extending from 11 O'Clock to 1 O'Clock meridians. In the super temporal sclera incision type, an incision of 6.5 mm was fashioned 3mm behind the limbus extending from 9 O'Clock to 11 O'Clock meridians. A backward cut of 1-1.5mm, radial to the limbus was made from each edge of the incision. A scleral tunnel was fashioned with a crescent blade. The incision extended approximately 1mm into the cornea. The dissection was carried out towards the limbus on both sides to create a funnel shaped "pocket". Anterior chamber was entered with the keratotome and then formed with vicomet. Anterior capsulotomy was performed with a bent 26-gauge needle. Hydro dissection was done. The incision was then extended and the nucleus was delivered out by sandwich method. Cortical aspiration was done using Simcoe cannula. Posterior chamber intra ocular lens (PCIOL) was inserted in all cases. The anterior chamber was then reformed with balanced salt solution.

On the immediate post-operative day, keratometry readings were taken in all patients. Post-operatively topical steroids and antibiotics second hourly were given. Generally the drops were tapered down to four times daily until a month after surgery. Tropic amide eye drops was prescribed for the first 2 weeks following surgery to all patients. Periodic examinations (Keratometry and slit lamp examination) were performed at 1st week, 3rd week and 6th week post-operatively. For the simplification of analysis, all the astigmatic changes (pre-operative and post-operative) were studied only in the vertical or horizontal axis (only at 90° and or at 180°). Oblique astigmatism was not studied. If the readings were oblique they were regarded as being with (at 90°) or against (at 180°) the rule, depending on their value (within 30°) proximity with the corresponding vertical or horizontal axis. Analysis of astigmatism was performed by subtraction method.

The course of post-operative astigmatic changes were determined by keratometry performed with a standard calibrated Bausch and Lomb keratometer. All changes of keratometry were recorded, tabulated for each corresponding period and the astigmatic decay for the two types of incisions was calculated using a statistically acceptable method. Z test was applied to find out the significant difference between the superior and super temporal scleral incisions.

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RESULTS:

The follow up of the cases showed that 18.18 % patients undergoing superior scleral incision had SIA above 2.5 dioptre (D) at any given time, whereas none of the patients who underwent super temporal incision showed such high SIA. On the contrary, less than 1 D of SIA was seen in 37.5 % patients undergoing superior scleral incision and in 85 % patients in super temporal group (Table-1).

In the present study, the incidence of post-operative against the rule (ATR) astigmatism increased from 48.9 % to 72 % i.e., by 24 % in superior incision group. In the super temporal incision it increased from 30.2 % to 45 % i.e., by 14.8 %. The incidence of post-operative with the rule (WTR) astigmatism decreased in superior incision group by 21.8 %, whereas in super temporal incision group it decreased by 13.1 %. However the decay in ATR astigmatism in super temporal group was from 0.868 $\pm$ 0.43 D to 1.04 $\pm$ 2.67 D (a change of 0.172 D) (Table- 2). In the superior group it was from 0.818 $\pm$ 0.67 D to 1.87 $\pm$ 1.15 D (a change of 1.052 D) (Table-3), implying that the super temporal incision is a better approach for patients with pre-operative astigmatism.

Table 1: Follow up of the astigmatism pattern in patients undergoing superotemporal and superior incision

Astigmatism in diopter	Supero-temporal incision		Superior incision	
	Number	%	Number	%
<0.5	18	45	6	12.5
0.6 to 1	16	40	12	25
1.1 to 1.5	4	10	5	10.4
1.6 to 2	2	5	6	12.5
2.1 to 2.5	0	0	10	20.8
>2.5	0	0	9	18.8
Total	40	100	48	100

Table 2: Decay of mean astigmatism in supero-temporal incision

Period	Number	WTR (Mean & SD)	Number	ATR (Mean & SD)
Pre-operative	23	0.53 $\pm$ 0.28	19	0.868 $\pm$ 0.43
1 st week	25	1.03 $\pm$ 0.59	13	0.807 $\pm$ 0.74
3 rd week	19	0.513 $\pm$ 0.25	17	0.647 $\pm$ 0.41
6 th week	18	0.569 $\pm$ 0.35	18	1.04 $\pm$ 2.67

Table 3: Decay of mean astigmatism in superior incision

Period	Number	WTR (Mean & SD)	Number	ATR (Mean & SD)
Pre-operative	23	1.13 $\pm$ 0.68	19	0.818 $\pm$ 0.67
1 st week	25	2.46 $\pm$ 1.11	13	1.63 $\pm$ 1.07
3 rd week	19	0.98 $\pm$ 0.94	17	1.67 $\pm$ 1.03
6 th week	18	0.673 $\pm$ 0.4	18	1.87 $\pm$ 1.15

Both the superior and super temporal groups showed an increase in gross astigmatism in the 1st post-operative week. In the super temporal group there was a constant decline in the gross astigmatism from 1st to 6th post-operative week. The mean SIA at 1st week after surgery following super temporal incision was 0.833 D that declined to 0.532 D at the end of 3rd week and to 0.487 D at 6th week. Thus, the decline in astigmatism was 0.301D between 1st and 3rd week and 0.045 D between 3rd and 6th week. In the superior incision group the decay was slower a 0.690 D decrease between 1st and 3rd week and then an increase by 0.256 D between 3rd and 6th week. This implies that a negligible (0.045D) change occurred in astigmatism from 3rd to 6th week in superotemporal incision.

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Table 4: Percentage of astigmatism

Post-operative	Superior incision		Supero-temporal incision	
	ATR	WTR	ATR	WTR
1 st week	23 (48.9%)	23 (48.9%)	13(30.2%)	25(58.1%)
3 rd week	20 (50%)	20 (50%)	17 (43.5%)	19(48.7%)
6 th week	35 (72.9%)	13 (27.1%)	18(45%)	18 (45%)

Table 5: Gross decay of astigmatism in superior and supero-temporal incisions

Period	Superior incision		Supero-temporal incision	
	Number	Mean & SD	Number	Mean & SD
Pre-operative	52	0.851+/- 0.77	44	0.653+/-0.382
1 st week	47	2.01+/-1.19	43	0.833+/-0.695
3 rd week	40	1.32+/-1.04	39	0.532+/-0.359
6 th week	47	1.576+/-1.13	40	0.487+/-0.358

The Z-test was used to compare SIA between the two groups (superior and superotemporal incision groups) and for change in astigmatism at 1st, 3rd and 6th week post-operatively within the same groups. On comparing SIA between the superior and superotemporal incisional group, there was a statistically significant difference ($p < 0.05$) implying that, the superotemporal incision causes less SIA than superior sclera incision. The change in SIA between 3rd and 6th postoperative group in superolateral incision group was statistically insignificant ($p > 0.05$) and statistically significant in superior incision group, which implies early spectacle correction can be done in superotemporal group when compared to superior incision group.

DISCUSSION

The corneal curvature changes following cataract surgery. There are various factors that influence the change in corneal topography like the location, size, depth of the incision, the technique and cautery used surface area of the wound etc. In our study, we have made an effort to analyse the difference in magnitude of SIA keeping other factors (length of the incision and depth) uniform between a superior and a superotemporal incision in manual SICS. Manual SICS is an alternative for phacoemulsification but the astigmatism is higher due to the larger size of incision. SIA increases with increase in incisional size (Burgansky *et al.*, 2002). In a developing country like India, where manual SICS is still practiced extensively, a simple change in the site of incision can have many advantages.

Recent advances in corneal topography provide valuable information about the corneal shape alteration induced by various types of surgeries. In a study conducted by (Ken and Fuminoroi, 1994) corneal topography was used to assess the surgically induced corneal shape alterations following superolateral and superior incision surgery. They found that, at end of one month, the mean SIA in superior incision was greater 1.43 ± 1.21 as compared to superotemporal which was 0.94 ± 0.66 which was similar to our study. We found that the final mean astigmatism at the end of 6th post-operative week was 1.576 ± 1.13 D in the superior incision group whereas it was only 0.487 ± 0.3578 D in the superotemporal group. At any given time 85% patients who underwent superotemporal incision had SIA < 1 D compared to 37.5% in superior scleral incision. This suggests that superotemporal incision causes less SIA. The difference in the magnitude of SIA between the two incisions was statistically significant. The present study shows a mean astigmatism after surgery following superotemporal incision at 1st week to be 0.833 D that declined to 0.532 D at the end of 3rd week and to 0.487 D at 6th week. Thus, the decline in astigmatism was 0.301 D between 1st & 3rd week and 0.045 D between 3rd & 6th week. In the superior scleral incision the decay was slower 0.690 D between 1st and 3rd week and 0.256 D between 3rd and 6th week. This implies that a negligible change (0.045 D) occurred in astigmatism from 3rd to 6th week in superotemporal incision. Thus, prescription of spectacles can be done as early as 3rd week following

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superotemporal incision. This study is similar to study where they found superotemporal incision led to early stabilization of astigmatism and early visual recovery (Nikhil and Saurabh, 2005).

Most of the studies conducted in the west, Ewa Bilinska et al., John et al., 1987, Altan Yaycioglu et al., Altan et al., 2007) have tried superotemporal approach mainly for phacoemulsification surgery and found that it causes less SIA thus proving the superiority of this incision in clear cornea phacoemulsification surgery. This study showed the superiority of superotemporal incision in SICS. In our study the incidence of post-operative ATR astigmatism increased in superior group from 48.9% to 72.9% ie., by about 24%, whereas in superotemporal incision it increased from 30.2% to 45% ie., by about 14.8%. On the other hand, post-operative WTR astigmatism decreased in superior incision group by 21.8% whereas in superotemporal it decreased by 13.1%. However the decay in ATR astigmatism in superotemporal group was from 0.868 ± 0.43 D to 1.04 ± 2.67 D a change of 0.172D whereas in superior group it was more from 0.818 ± 0.67 D to 1.87 ± 1.15 D a change of 1.052D thus, implying that superotemporal incision is a better approach for patients with pre-operative ATR astigmatism.

The mechanism by which superotemporal approach is associated with reduced post-operative decay in SIA is unproven but the cause appears obvious. It is generally recognized that there is a tendency towards an ATR shift in astigmatism with age in the absence of anterior segment surgery. The incessant stroking of superior limbus with upper eyelid is probably responsible. The temporal location is farthest from the visual axis and any flattening due to the wound is less likely to affect the corneal curvature at the visual axis. When the incision is located superiorly, both gravity and eyelid blink tend to create a drag on the incision. These forces are neutralized well with temporally placed incisions because the incision is parallel to the vector of the forces. With the ride astigmatism induced by a temporal incision is advantageous because most elderly cataract patients have pre-operative against the rule astigmatism. The superotemporal incision also, is probably free from the effect of gravity and eyelid pressure and tends to induce less astigmatism. The supero-temporal has an added advantage that it can be performed more easily in deep set eyes. Our study clearly demonstrated the advantages of superotemporal over superior scleral incision.

CONCLUSION

Cataract surgery incisions have been known for more than a century to influence astigmatism. One of the reasons for this study was to determine if changes in the procedure might reduce the total astigmatism. The results show that SIA in the superotemporal incision is significantly less when compared to superior incision in SICS. The decay of astigmatism from 3rd to 6th week in superotemporal incision is negligible compared to superior incision, implying early wound stabilization and therefore early spectacle correction (by 3rd week after surgery) in superotemporal incision type. The supero-temporal incision avoids the 12 O' clock limbus and thus allows any filtering surgeries if required later at the superior limbus site. Thus, in a developing country like India where manual SICS is still practiced extensively, a simple change in the site of incision can have many advantages.

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