To compare surgically induced astigmatism in SICS using two different incision sites – "superior vs. temporal"

Rohit Saxena[1,*], Poonam Kishore[2], Sandeep Saxena[3]

[1]Assistant Professor, [2,3]Professor, Dept. of Ophthalmology, [1]Hind Institute of Medical Sciences, Barabanki, [2,3]King George Medical University Lucknow

***Corresponding Author:**
Email: dr_saxena13@yahoo.com

Abstract

Cataract is one of the most important curable causes of blindness in India. Nowadays although the 'cataract surgery of choice' is phacoemulsification; manual small incision cataract surgery (SICS) has emerged as an alternative technique owing to its being cost-effective and having all advantages of a self-sealing sutureless incision but with the disadvantage of having higher postoperative astigmatism. The aim of our study was to compare the surgical outcome using two different incision sites – "superior and temporal" in terms of surgically induced astigmatism.

After taking Informed consent all the patients were divided randomly into two groups. Group S received Superior incision and group T Temporal incision. All surgeries were performed under peribulbar anesthesia using an incision size of 6 – 6.5 mm. The incision architecture was kept same in both the groups.

Postopratively patients were examined on days 1, 7, 30, 45 and 90. Keratometry with Uncorrected and Best corrected visual acuity was recorded on subsequent visits. The surgically induced astigmatism (SIA) was calculated by Vector method. When SIA was compared between the two groups, both in magnitude as well as axis, the change was found to be lower in temporal group as compared to superior group S. It was statistically significant (p=0.004).

We therefore conclude that though both the groups had good postoperative visual acuity patients of group S had more postoperative and surgically induced astigmatism and therefore greater dependence on spectacles as compared to group T and this was found to be statistically significant.

Keywords: Cataract, Small incision cataract surgery (SICS), Surgically induced astigmatism (SIA), Vector method.

Introduction

Cataract, currently, is one of the most important curable causes of blindness in India. One of the major complications of cataract surgery is the development of postoperative astigmatism which cannot be completely removed as it develops as a result of healing. It can only be minimized by making changes in the technique of surgery, most important of which is changing the size and site of incision.

Nowadays although the 'cataract surgery of choice' is phacoemulsification; manual small incision cataract surgery (SICS) has emerged as an alternative technique of cataract surgery owing to it being cost-effective and having all advantages of a self-sealing sutureless incision.[(3)]

SICS is therefore a boon for developing countries like ours , but comes with its own set of disadvantages, of which the most important is the larger size of incision as compared to phacoemulsification which leads to higher postoperative astigmatism. Higher postoperative astigmatism would mean greater difficulty in doing day to day activities with unaided eyes and therefore higher dependency on glasses.

Most of the work in the past has been done with the main intension for finding the way to have minimum postoperative astigmatism. The investigators found that surgically induced astigmatism depends upon various factors like the incision architecture, the distance from limbus, shape of incision, tunnel length, and above all the site of incision. Different sites of incision like superior, temporal and oblique have been tried. Different investigators have done work over this and have come up with different results.

This study was therefore performed to evaluate and compare the difference in surgically induced astigmatism and visual outcome using two different incision sites: "Superior vs. Temporal". When SIA was compared between the two groups, both in magnitude as well as axis, it was found to be statistically lower in temporal group as compared to superior group.

Materials and Methods

A Tertiary care centre based prospective interventional study was undertaken. The study was conducted on patients attending the outpatient unit of Department of Ophthalmology, King George Medical University, Lucknow.

The inclusion criteria consisted of patients with cataract with nuclear grade 1-3 with Keratometric astigmatism of 2.0 D or less. Patients with Pre-existing astigmatism due to associated ocular diseases like pterygium or corneal opacity and associated systemic conditions which could alter the visual outcome like diabetes mellitus and hypertension were excluded.

Informed consent was taken from all the patients. The patients were divided randomly into two groups. Group S received Superior incision and group T Temporal incision (Table 1). Both the superior and the

temporal groups were compared statistically to find whether the two groups were comparable. No significant difference was seen between the two groups. The groups were matched age and sex wise (p>0.05).

Table 1: Participant Flow

Characteristic	Group S (n=18)	Group T (n=17)
Sex		
Female	9	9
Male	9	8
χ^2=0.030 (df=1); p=0.862 (NS)		
Age (Mean±SD)	56.78±4.634	58.18±3.187
"t"=1.034; p=0.309 (NS)		

All surgeries were performed under peribulbar anesthesia. Manual SICS was done using an incision size of 6 – 6.5 mm. The incision architecture was kept same in both the groups. Post-operative patients were administered Prednisolone acetate and Gatifloxacin eye drops for six weeks post-operatively. Patients were examined on days 1, 7, 30, 45 and 90. Uncorrected and Best corrected visual acuity was recorded on subsequent visits. Keratometry was recorded on subsequent visits. Corneal topography was done pre operative and 90 days post operative.

Statistical methods used for evaluation were Student "t" Test and Chi Square test. The Vector method was used for the calculation of surgically induced astigmatism.

Results and Discussion

The preoperative astigmatism of the two groups was evaluated before proceeding with the study to look for any bias in the two study groups. There was no statistically significant difference in mean astigmatic magnitude and axis between the two groups though the mean values were higher in temporal group as compared to superior group. The p value for magnitude and axis of astigmatism were 0.053 and 0.217 which were not statistically significant. Thus the two groups were comparable (Table 2).

Table 2: Preoperative Astigmatism (Values in Mean±SD)

Astigmatism	Group S (n=18)	Group T (n=17)	"t"	"p"
Magnitude (K1)	0.864±0.286	1.071±0.321	2.008	0.053
Axis (A1)	124.67±58.358	96.00±75.845	1.257	0.217

The superior group (Table 3) with 18 patients was evaluated preoperatively by corneal topography to find the accurate amount of preoperative astigmatism both in terms of magnitude and direction which is referred as K1 for magnitude and A1 for astigmatism. The postoperative keratometry was also calculated by corneal topography which was done on postoperative day 90. This is referred to as K3 and A3. The surgically induced astigmatism (SIA) was calculated by Vector method by considering the preoperative astigmatism as K1 and A1 and postoperative astigmatism as K3 and A3 and was found to have mean and standard deviation of 0.85 and 0.38 for magnitude and 118.06 and 72.11 for axis respectively.

Table 3: Group S – Astigmatism findings

Pt. ID	Pre-op		Post-op												SIA	
	K1	A1	Day 1		Day 7		Day 15		Day 30		Day 90		K3	A3	K2	A2
			V	H	V	H	V	H	V	H	V	H				
S1	0.75	84	43.75	43.25	43.75	43.00	43.50	43.00	43.25	43.25	43.50	43.25	0.35	80	0.41	177
S2	0.75	152	43.75	45.00	43.75	45.00	43.50	45.25	43.50	45.50	43.50	45.50	1.92	160	1.22	165
S3	1.38	74	43.50	42.50	43.75	42.25	43.75	42.75	43.50	42.50	43.50	42.75	0.66	82	0.77	157
S4	0.60	174	47.50	48.50	47.50	48.75	47.25	48.75	47.50	49.00	47.25	49.00	1.64	168	1.06	165
S5	0.52	180	45.00	45.75	45.25	46.00	45.00	46.50	44.75	46.75	45.00	46.75	1.52	168	1.00	164
S6	0.88	170	45.50	46.50	45.25	46.25	45.50	46.75	45.75	46.75	45.75	46.75	1.13	178	0.37	18
S7	0.75	48	47.00	46.50	47.25	46.75	47.50	46.50	47.00	46.75	47.25	46.75	1.00	40	0.35	22
S8	1.25	160	42.50	43.75	42.25	43.50	42.00	43.75	42.00	44.00	42.00	44.00	1.75	12	1.65	34
S9	0.88	32	46.50	47.50	46.50	47.50	46.25	47.75	46.00	47.75	46.25	47.75	1.88	18	1.18	8
S10	0.76	154	43.75	44.75	43.75	44.75	43.50	45.00	43.50	45.80	43.50	45.50	1.93	162	1.22	167
S11	1.46	76	43.75	42.50	43.50	42.50	43.25	42.75	43.25	42.75	43.25	42.75	0.60	82	0.88	162
S12	0.77	170	47.50	48.50	47.25	48.75	47.00	49.00	47.25	49.00	47.00	49.00	1.75	168	0.98	166
S13	0.56	178	45.00	45.75	45.25	46.00	45.00	46.25	45.00	46.25	45.00	46.50	1.54	170	1.01	166
S14	0.85	172	45.25	46.25	45.50	46.50	45.25	46.75	45.50	46.75	45.50	46.75	1.14	174	0.30	180
S15	0.75	48	45.50	46.25	45.50	46.50	45.25	46.50	45.25	46.50	45.25	46.50	1.00	42	0.31	27
S16	1.25	162	42.25	43.50	42.25	43.50	42.00	43.75	42.00	44.00	42.00	44.00	1.87	164	0.63	168
S17	0.88	30	45.50	46.50	45.25	46.75	45.00	47.00	45.00	47.25	45.00	47.25	1.74	18	1.00	8
S18	0.52	180	44.00	44.75	44.00	45.00	44.25	45.50	44.25	45.50	44.25	45.50	1.38	174	0.88	171
Mean	0.86	124.67	44.86	45.44	44.86	45.51	44.71	45.75	44.68	45.89	44.71	45.90	1.38	114.44	0.85	118.06
S.D.	0.29	58.36	1.58	1.84	1.60	1.97	1.64	1.93	1.66	1.94	1.64	1.92	0.50	65.44	0.38	72.11

The temporal group (Table 4) with 17 patients was similarly evaluated preoperatively by corneal topography to find the accurate amount of preoperative astigmatism both in terms of magnitude and direction. This is referred as K1 for magnitude and A1 for astigmatism. The postoperative keratometry was also calculated by corneal topography which was done on postoperative day 90. This is referred to as K3 and A3. The surgically induced astigmatism (SIA) was calculated by Vector method by considering the preoperative astigmatism as K1 and A1 and postoperative astigmatism as K3 and A3 and was found to have mean and standard deviation of 0.58 and 0.23 for magnitude and 89.18 and 36.64 for axis respectively.

Table 4: Group T – Astigmatic findings

Pt. ID	Pre-op		Post-op												SIA	
	K1	A1	Day 1		Day 7		Day 15		Day 30		Day 90		K3	A3	K2	A2
			V	H	V	H	V	H	V	H	V	H				
T1	1.00	172	43.25	44.25	43.50	44.50	43.50	44.50	43.75	44.50	43.75	44.50	0.50	178	0.52	76
T2	0.75	166	45.25	46.00	45.50	46.25	45.75	46.25	45.75	46.25	45.75	46.25	0.35	172	0.41	71
T3	1.00	36	46.50	47.50	46.75	47.25	47.00	47.50	46.75	47.25	46.75	47.25	0.54	28	0.50	135
T4	1.37	32	38.50	39.75	38.50	40.00	38.50	40.25	38.75	40.00	39.00	40.00	1.00	24	0.49	139
T5	0.50	164	43.25	43.75	43.00	43.75	43.50	43.50	43.50	43.25	43.50	43.25	0.15	170	0.35	71
T6	1.00	2	43.25	44.00	43.00	44.25	42.75	44.50	42.75	44.75	42.75	44.75	2.00	12	1.11	21
T7	1.50	180	40.00	41.50	40.50	41.25	40.75	41.00	40.50	41.00	40.75	41.00	0.94	180	0.58	90
T8	1.50	6	44.00	46.25	44.50	46.00	45.00	45.75	45.25	45.75	45.50	45.75	0.94	10	0.68	90
T9	1.10	174	42.50	43.50	42.75	43.25	43.00	43.00	43.50	42.75	43.50	42.75	0.56	178	0.50	80
T10	0.77	168	44.25	45.00	44.75	45.25	44.50	45.50	44.75	45.00	44.50	45.00	0.43	172	0.35	73
T11	1.00	40	45.50	46.50	45.75	46.25	46.00	45.75	45.50	45.75	45.75	46.00	0.60	32	0.45	141
T12	1.37	34	39.25	41.00	39.75	40.75	39.50	40.50	40.00	40.00	40.25	40.00	1.10	22	0.58	149
T13	0.50	168	42.00	43.00	42.50	42.75	42.25	42.50	42.00	42.00	42.50	42.25	0.16	172	0.34	76
T14	1.02	4	42.25	43.00	42.00	43.50	41.75	44.00	42.00	44.25	45.50	43.75	1.96	14	1.06	24
T15	1.42	174	40.50	42.50	40.75	42.00	41.25	42.50	41.50	42.25	41.75	42.50	0.54	172	0.88	85
T16	1.40	12	43.50	45.00	44.00	45.50	43.75	45.25	44.25	45.00	44.50	45.50	0.86	8	0.56	108
T17	1.00	100	44.00	43.25	44.50	43.25	44.50	43.00	44.00	42.50	44.25	42.50	1.40	96	0.43	87
Mean	1.07	96.00	42.81	43.87	43.06	43.87	43.13	43.84	43.21	43.66	43.54	43.71	0.83	96.47	0.58	89.18
S.D.	0.32	75.85	2.21	2.06	2.24	2.09	2.30	2.08	2.19	2.17	2.15	2.18	0.55	78.01	0.23	36.64

Postoperatively (Table 5) mean astigmatism, both in magnitude as well as axis, was compared in the superior and temporal groups and was found to be lower in temporal group as compared to superior group. It was found to be statistically significant for magnitude (p=0.017). The SIA as calculated by Vector method was compared both in magnitude as well as axis in both the groups and it was found to be lower in temporal group as compared to superior group. It was found to be statistically significant for magnitude (p=0.004).

Table 5: Comparison of Astigmatism between the two groups

	Astigamatism	**Group S (n=18)**	**Group T (n=17)**	**"t"**	**"p"**
Pre-op	Magnitude (K1)	0.86±0.29	1.07±0.32	2.008	0.053
	Axis (A1)	124.67±58.36	96.00±75.85	1.257	0.217
Post-op	Magnitude (K3)	1.38±0.50	0.83±0.55	2.504	0.017
	Axis (A3)	114.44±65.44	96.47±78.01	0.740	0.464
SIA	Magnitude (K2)	1.38±0.50	0.825±0.548	2.504	0.017
	Axis (A2)	114.44±65.44	96.47±78.02	0.740	0.464

The demographics of patients included in the study had a comparable age and sex distribution. The age of the patients in Group S were in the range of 48 – 63 years with a mean of 56.78±4.634 and the patients of group T were in the range of 54 – 62 years with a mean of 58.18±3.187. Both the superior and the temporal group were compared statistically to find whether the two groups were comparable. No significant difference was seen between two groups. The groups were matched age and sex wise (p>0.05).

Most of the studies in the past literature had used manual keratometer for measuring the amount of corneal astigmatism. However this is not recommended as it measures only four data points within the cornea's central 3-4mm. Moreover the human error with manual keratometer cannot be overlooked. Corneal topography however solves both these problems. Astigmatism calculated by corneal topography is accurate as it evaluates 8,000 to 10,000 specific points across the entire corneal surface and therefore gives a measure of the whole cornea. Since it is measured by an automated device there are no chances of human error. Therefore in our study we had taken values generated by corneal topography for our final measurements.

The postoperative astigmatism of the two groups was evaluated on day 1, 7, 30, 45 and 90 by manual keratometer. This was to demonstrate the way the corneal curvatures change with the healing process with time. On day 90, corneal topography was done to estimate the accurate postoperative astigmatism and this value was used for further calculations. Group S had a magnitude (K3) of 1.378±0.497 and Axis (A3) 114.44±65.44. Similarly Group T had a magnitude (K3) of 0.825±0.548 and Axis (A3) 96.47±78.02. The "t" test for magnitude had a value of 2.504 and for axis 0.740. Postoperatively, mean astigmatism, both in magnitude as well as axis, was compared in the superior and temporal groups and was found to be lower in temporal group as compared to superior group S. It was found to be statistically significant for magnitude (p=0.017).

The findings of manual keratometer show the changes in corneal astigmatism with time and the findings of corneal topography show the final corneal astigmatism change from preoperative status to postoperative stage. It was found that with time the changes take place in both the meridians, the meridian parallel to the line of incision and the meridian perpendicular to the line of incision. It was found that the drift in the curvature of cornea in both the groups was in such a way that it produced flattening in the meridian perpendicular to it and steepening in the meridian parallel to it.

The postoperative visual acuity is a direct reflection of the postoperative corneal astigmatism. Evaluation of both the groups proved that postoperative astigmatism had a direct influence on the postoperative visual acuity, with increase in the postoperative astigmatism leading to a decrease of visual acuity. Out of the 18 patients in group S, 15 patients had a postoperative astigmatism of >= to 1.0 with a visual acuity without astigmatism correction of >= 6/12 & N8 in comparison to remaining 3 patients which had postoperative astigmatism < 1.0 with a visual acuity without astigmatism correction of < 6/12 & N8. In comparison to group S, group T had a better result. Out of the 17 patients in group T, 5 patients had a postoperative astigmatism of >= to 1.0 with a visual acuity without astigmatism correction of >= 6/12 & N8 in comparison to remaining 12 patients which had postoperative astigmatism < 1.0 with a visual acuity without astigmatism correction of < 6/12 & N8. This comparison between the postoperative astigmatism and visual acuity indicates that patients of group T have an overall better visual acuity than patients of group T and this is a clear reflection of the amount of postoperative astigmatism in the two groups.

The past has witnessed a number of methods for the evaluation of surgically induced astigmatism (SIA). Various studies had been carried out to find out the most appropriate method which was also comparable and internationally acceptable. There have been various methods like methods of Naylor, Jaffe,[5] Kaye, Holladay,[12,14] Olsen,[13] Naeser[11] polar value analysis and the methods later described by Alpins,[9] and Holladay.[14]

The Vector method described by Stokes[4] in 1849 and later by Jaffe and Clayman,[5] is perhaps the most

straightforward method which incorporates both magnitude and direction. This method relies on geometrical principles and graphing of the direction and magnitude of preoperative and postoperative astigmatism on paper to determine the surgically induced vector. Because the graph covers 360 degrees, the axis was doubled before drawing the vector on paper. This study therefore used the Vector method for calculating the surgically induced astigmatism.

Our study (Table 6) confirms the findings of Wirbelauer *et al* (1997)[19] Kimura H *et al* (1999).[2] Our study also favors the finding of Oshika *et al* (2000)[22] who found that the superior incision group showed slight against-the-rule astigmatic changes, whereas slight with-the-rule astigmatism was seen in the temporal incision group. Our study also favours the findings of Gokhale *et al* (2005)[24] who also found that amplitude of surgically induced astigmatism as calculated by the vector method was higher in group with superior incision (1.36 ± 1.03) than in group with temporal site of incision (0.40 ± 0.40) and concluded that shift in the incision site to temporal sclera is recommended except in patients with a pre-existing 'with the rule' astigmatism.

Table 6: Comparison with other studies

Study	SIA	SIA
	Superior incision	**Temporal incision**
Wirbelauer *et al* (1997)	1.16+/-0.44	0.66+/-0.32
Gokhale *et al* (2005)	1.36+/-1.03	0.40+/-0.40
Reddy *et al* (2007)	1.92+/-0.53	1.57+/-0.24
Present study	0.846±0.382	0.576±0.233

Conclusion

Evaluation of the induced astigmatism and visual outcome after manual SICS using two different incision sites "Superior vs. Temporal" showed that patients of group S had more surgically induced astigmatism as compared to group T and this was found to be statistically significant. Greater SIA in group S resulted in a greater dependence on spectacles. The results of this study were found to be comparable to other researchers. Shift in the incision site to temporal sclera is recommended except in patients with a pre-existing 'with the rule' astigmatism. However the results need to be validated with a larger study.

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