

Evaluation of Surgically Induced Astigmatism (SIA) in 2.8 mm Superior Clear Corneal Incision after Phacoemulsification

Amrita Singh, Ashok K Sharma, Hans Raj Sharma

Abstract

A prospective study was conducted in upgraded department of ophthalmology Government Medical College Jammu. The aim was to evaluate the surgically induced astigmatism (SIA) by 2.8 mm superior clear corneal incision after phacoemulsification. Fifty eyes of exact number of patients were included in the study. The average age and preoperative astigmatism was computed. All patients were treated with 2.8 mm clear corneal superior approach phacoemulsification. Patients received detailed ophthalmological investigations in addition to keratometry both pre- and post-operatively. SIA was calculated by using SIA Calculator Version 2.1. Age wise the cataract patients were in all four age groups of 41-50 years (15/30%), 51-60 years (14/28%), 61-70 years (18/36%) and 71-80 years (3/6%). The mean age of cataract patients was 56.8 ± 9.31 years. The preoperative astigmatism under study patients ranged from 0 D to 2.25 D. 80% of the cataract patients had preoperative astigmatism to the levels of 1.0 D and 20% patients 1.25 D and above. On all intervals of study period the SIA range was up to 3.0 D. Postoperatively from day-1 to week-6 intervals, SIA not only decreased but also shifted to lower range. Final mean values of SIA were 1.565 ± 0.555 D, 1.425 ± 0.690 D, 1.02 ± 0.686 D, and 0.66 ± 0.67 D on day-1, week-1, -4 and -6 respectively. The uncorrected visual acuity was 6/36 to 6/18 in 10 (20%) patients and 6/12 to 6/6 in 40 (80%). The best corrected visual acuity was 6/36 to 6/18 in 8 (16%) patients and 6/12 to 6/6 in 42 (84%) patients.

Key Words

Cataract, Phacoemulsification, Surgically Induced Astigmatism

Introduction

Cataract is the leading treatable cause of blindness by means of surgery. Surgery is usually associated with procedure related astigmatism called SIA.

The aims of modern cataract surgery are smaller incision size; rapid visual rehabilitation and minimum SIA (1). Phacoemulsification fulfils all these aims and therefore has evolved as the preferred surgical procedure for cataract extraction followed by insertion of a foldable intraocular lens through small incision, best possible uncorrected visual acuity, and minimal SIA (2).

Factors affecting SIA are the size (3); site of incision (4), pre-existing astigmatism (5) and the patient's age (6). In present study the aim was to evaluate SIA in 2.8 mm superior clear corneal incision after phacoemulsification.

Material and Methods

Fifty patients in the age group of 41 to 80 years diagnosed for cataract were enrolled in the study. Same number of eyes were subjected to superior approach

From the Deptt. of Ophthalmology, Govt. Medical College, Jammu.(J&K), India

Correspondence to : Dr Hans Raj Sharma, Associate Professor, Department of Ophthalmology, Govt. Medical College, Jammu. (J&K), India

phacoemulsification and posterior chamber intraocular lens implantation (PCIOL). Ethical approval was obtained from the institutional ethical committee and informed consent was obtained from all patients.

Table 1. Characteristics of population

Age groups (Years)	Age wise No of cases/ %age	Gender wise	
		Male / Female (No. of cases)	Male / Female (%age)
41 - 50	15 / 30	07 / 08	14 / 16
51 - 60	14 / 28	09 / 05	18 / 10
61 - 70	18 / 36	10 / 08	20 / 16
71 - 80	03 / 06	02 / 01	04 / 02
Total	50 / 100	28 / 22 = 50	56 / 44 = 100
Mean	56.8		
S.D	9.31		
Test statistic value	t= 1.37	$\chi^2 = 1.96$	
Table value	$t_{0.05,49} = 1.671$	$\chi^2_{0.05,1} = 3.85$	

After placing a wire speculum, povidone iodine (betadine) was used to clean the eye. Two side ports were created with MVR blade at 10 o'clock and 2 o'clock positions. Viscoelastic was injected into anterior chamber and continuous curvilinear capsulorrhexis was performed with bent-tipped 26 gauge needle. Thereafter, 2.8 mm clear corneal incision in the superior quadrant was given with the help of 2.8 mm kerotome.

Then hydro-dissection was performed. A phaco probe was passed through the main incision to emulsify the nucleus. The surrounding cortex was removed with the help of irrigation aspiration cannula. The capsular bag was filled with viscoelastic solution. A foldable acrylic lens with injector system was placed in capsular bag. Viscoelastic material was removed using irrigation aspiration probe. Anterior chamber was formed and superior incision and side ports were hydrated with balanced salt solution.

Postoperative steroid antibiotic ointment was applied and pad and bandage was done. Patients were followed postoperatively on day-1, week-1, -4 and -6 for visual acuity, slit lamp examination, keratometry, and refraction. During follow up complications if any were recorded and treated accordingly.

Table 2. Preoperative- and Surgically Induced- Astigmatism (SIA) Evaluated in Fifty Patients Under Study

Astigmatism Diopter (D)	Preoperative No of cases/ %age	Surgically Induced Astigmatism (SIA) No of cases / %age			
		Day- 1	Week- 1	Week- 4	Week- 6
0.00	04 / 08	00 / 00	00 / 00	02 / 04	14 / 28
0.25	07 / 14	01 / 02	00 / 00	04 / 08	06 / 12
0.50	11 / 22	02 / 04	06 / 12	07 / 14	10 / 20
0.75	08 / 16	05 / 10	04 / 08	08 / 16	04 / 08
1.00	10 / 20	07 / 14	10 / 20	13 / 26	04 / 08
1.25	04 / 08	10 / 20	09 / 18	05 / 10	03 / 06
1.50	03 / 06	06 / 12	06 / 12	04 / 08	07 / 14
1.75	01 / 02	06 / 12	03 / 06	01 / 02	00 / 00
2.0	01 / 02	01 / 02	02 / 04	02 / 04	00 / 00
2.25	01 / 02	04 / 08	03 / 06	02 / 04	01 / 02
2.50	00 / 00	00 / 00	02 / 04	02 / 04	00 / 00
2.75	00 / 00	03 / 06	04 / 08	00 / 00	00 / 00
3.0	00 / 00	05 / 10	01 / 02	0 / 0	01 / 02
Mean	0.775	1.565	1.425	1.020	0.660
S.D	0.504	0.555	0.690	0.686	0.670
Test statistic t value	1.041	0.209	0.139	0.056	0.019
Table value $t_{0.05,49}$			1.671		

Table 3: Pre- and Post-operative visual acuity among study patients

Preoperative visual acuity	Number of cases	%age	Post-operative visual acuity	Uncorrected No. of cases	%age	Best corrected No. of cases	%age
PL+PR+	4	8	6/60 or less	0	0	0	0
FCCF to 5/60	16	32	6/36 – 6/18	10	20	8	16
6/60 to 6/18	30	60	6/12 – 6/6	40	80	42	84
Total	50	100	Total	50	100	50	100
Chi square (χ^2)	13.82		Chi square (χ^2)	17.33		18.57	
Test value			Test value				
Table value	9.21		Table value	9.21			
² _{0.01,2}			² _{0.01,2}				

Both pre- and post-operative keratometric horizontal (K1) and keratometric vertical (K2) were measured by Bausch and Lomb Keratometer. Astigmatic magnitude was quantified in dioptres (D) and axis direction was depicted in degrees. Results were analysed using SIA Calculator Version 2.1 (7).

Patients included in the study were randomly chosen and known principles of inference were applied. The data generated was tabulated and subjected to statistical analysis (8).

Results

Age wise distribution of patients: Study patients were in the age group of 41 to 80 years. Age wise these patients in different groups were 15 (30%) in 41-50 years, 14 (28%) in 51-60 years, 18 (36%) in 61-70 years and 03 (6%) in 71-80 years. Mean age was 56.8 ± 9.31 years. The calculated value t (1.37) was less than tabulated value $t_{0.05,49}$ (1.671) showing that mean age 56.8 ± 9.31 years of cataract patients was the age of the population (Table 1).

Gender wise distribution of patients: Gender wise 28 (56%) patients were males and 22 (44%) females. The calculated test value χ^2 (1.96) was less than the tabulated value 2.05,1 (3.85) and thus the gender wise cataract patients were equally probable (Table 1).

Preoperative astigmatism: The preoperative astigmatism range was 0.0 - 2.25 D. Only 20% patients had above 1.0 D level of astigmatism and rest 80% patients 1.0 D and below level. The variable degree preoperative astigmatism was 0.0 D in 4 (8%) patients, 0.25 D in 7 (14%) patients, 0.50 D in 11 (22%) patients, 0.75 D in 8

(16%) patients, 1 D in 10 (20%) patients, 1.25 D in 4 (8%) patients, 1.5 D in 3 (6%) patients and 1.75 D to 2.25 D in 1 (2%) patient each. The computed t value (1.041) was less than the tabulated value $t_{0.05,49}$ (1.671) indicating that the preoperative astigmatism 0.775 ± 0.504 D was the mean value of the population (Table 2).

Surgically induced astigmatism (SIA): SIA range was 0.0 - 3.0 D in all postoperative intervals of the study. With the increase in intervals of observations the SIA levels decreased and shifted to lower levels. On day- 1, SIA was 0.25 - 0.75 D in 8 (16%) patients, 1.0 - 1.50 D in 23 (46%) patients, 1.75 - 2.25 D in 11 (22%) patients, 2.75 - 3.0 D in 8 (16%) patients.

On week- 1, SIA was 0.0 - 0.75 D in 10 (20%) patients, 1.0 - 1.5 D in 25 (50%) patients, 1.75 - 2.25 D in 8 (16%) patients and 2.50 - 3.0 D in 7 (14%) patients.

On week- 4 interval, 21 (42%) patients experienced SIA 0.00 - 0.75 D, 22 (44%) patients 1.0 - 1.5 D, 5 (10%) patients 1.75 - 2.25 D and 2 (4%) patients 2.50 D.

On week- 6 interval, there was considerable decrease in SIA to lower levels as 34 (68%) patients 0.0 - 0.75 D, 14 (28%) patients 1.0 - 1.50 D, and 1 (2%) patient each 2.25 D and 3.0 D.

The mean SIA values were 1.565 ± 0.555 D; 1.425 ± 0.690 D; 1.02 ± 0.686 D; 0.66 ± 0.67 D on postoperative day-1; week- 1, -4 and -6 respectively (Table 2).

Summing up over all trends of SIA under study, it exhibited stair case like trends shifting from higher degree to lower degree with the advancement of postoperative intervals. Statistical analysis revealed that at all intervals of the study the computed values of t at 5% level of

significance were much lower to the tabulated value ($t_{0.05,49} = 1.671$). These results indicated that sample mean of SIA was the mean of the population.

Visual acuity: Preoperative visual acuity under various parameters such as PL+PR+ (perception of light, projection of light), FCCF (finger count close to face) to 5/60 and 6/60 to 6/18, the number of cases were 4 (8%), 16 (32%) and 30 (60%) respectively.

As regards postoperative visual acuity, the uncorrected visual acuity was 6/36 to 6/18 in 10 (20%) patients and 6/12 to 6/6 in 40 (80%). The best corrected visual acuity was 6/36 to 6/18 in 8 (16%) patients and 6/12 to 6/6 in 42 (84%) patients (*Table 3*).

Computed test values of these parameters were higher than the tabulated value. These results indicated that these parameters were different in the population.

Discussion

Patients included in the study bearing age range from 41- 80 years, the mean age of cataract was 56.8 ± 9.31 years. The computed statistic value ($t = 1.37$) was less than table value ($t_{0.05,49} = 1.684$) showing that there was no deviation between sample mean and population.

Various workers in their studies under different age range have reported the mean age of cataract patients 69.2 ± 7.8 years (range 50-87 years) (9) and 61.5 ± 8.99 (range 45 to 82 years). (10)

As regards gender distribution, the males were 28 (56%) and females 22 (44%) and computed test value ($t = 1.96$) was also less than the table value $t_{0.05,1} = 3.85$ (*Table 1*).

These results closely corroborated to the reporting by Roman et al. (57.78% males and 42.22% females) (11), Gokhale et al. (57.14 males and 42.86 females) (10), Madhu and Raj (56% males and 44% females) (12) and Mukherji et al. (57.14 males and 42.86 females). (13)

Preoperative corneal astigmatism can cause blurred or impaired unaided vision and postoperatively can reduce final unaided visual outcome after cataract surgery (14). Correcting it at the time of cataract surgery can give spectacle independence for distant vision (15). A smaller number of studies have attempted to ascertain the prevalence of preoperative cataract astigmatism (15,16). A clear corneal incision given during phacoemulsification at steep meridian of cornea have been reported to reduce

pre-existing astigmatism (4,17) but can be unpredictable for correction of 1.5 D or more of astigmatism (18).

In our study the range of astigmatism in cataract patients was 0.0 - 2.25 D and the mean 0.775 ± 0.504 D. Astigmatism above 1.0 D was observed in 10 (20%) patients and balance 40 (80%) patients had 1.0 D and less astigmatism. The calculated test value ($t = 1.041$) was less than the table value ($t_{0.05,49} = 1.671$) indicating that sample mean and population mean do not differ significantly.

As compared to preoperative astigmatism , mean in our study is (0.775 ± 0.504 D) greater values have been reported by Ferrer-Blasco et al. (0.90 ± 0.93), (15) Khan et al, (1.03 ± 0.728) (16) and David and Patric (1.09 ± 0.83 D) (19).

Preoperative cataract astigmatism greater than 1.5 D has been reported variously to affect 15 to 22 % of the population (Ferrer-Blasco et al.(15) and Khan and Muhtaseb (16) In our study, astigmatism 1.5 D and above was found in 12% population.

Post surgical high astigmatism is one of the reasons behind unsatisfying visual outcomes of cataract procedure. The modern cataract surgery is gauged successful in terms of quicker visual and functional recovery and least surgical astigmatism. It is possible by advanced suture less cataract surgery techniques by phacoemulsification followed by posterior chamber Intraocular Lens (IOL) implantation.

The range of SIA was 0.25 - 3.0 D on day-1, 0.50 - 3.0 D on week-1, 0.0 - 2.50 D on week-4 and 0.0- 1.50 D on week-6. At last interval of week-6 only one patient each recorded SIA 2.25 D and 3.0 D.

There was significant shift towards lower degree of SIA with the advancement of postsurgical intervals. SIA on week-6 was 0.00 D in 14 (28%) patients, on 0.25 D in 6 (12%) patients, 0.50 D in 10 (20%) patients, 0.75-1.0 D in 8 (16%) patients, 1.25 D in 3 (6%) patients and 1.50 D in 7 (14%) patients. The mean SIA values decreased with increasing intervals of observations as 1.565 ± 0.555 on day-1, 1.425 ± 0.690 on week-1, 1.020 ± 0.686 on week-4 and 0.660 ± 0.670 on week-6. The test statistics values computed in all intervals of study were less than table value. As compared to our SIA findings on week-6 (0.66 ± 0.67 D), using superior corneal incision phacoemulsification various workers have reported both higher and lower degree of SIA. Gaide and Khaire (18)

on 40th day interval recorded SIA with superior approach 0.585 ± 0.464 D the SIA values less than our study. Higher SIA was recorded by Marek *et al* (21) after six month interval (SIA 1.0 ± 0.54 D) and Simsek *et al* (22) (1.44 ± 0.31 D).

In our study 48 (96%) patients on week-6 exhibited SIA range from 0.00 - 1.5 D and in only one (2%) patient each SIA was 2.25 D and 3.0 D. These trends corroborated the findings of Gade and Khaire (18) reporting SIA range 0.00 D - 1.5 D on 40th postoperative day.

As regards visual acuity, preoperative 6/60 to 6/18 was found in 30 (60%) patients, FCCF to 5/60 in 16 (32%) patients and PL + PR+ in 4 (8%) patients. Uncorrected visual acuity was 6/36 to 6/18 in 10 (20%) and 6/12 to 6/6 in 40 (80%) patients. The best corrected visual acuity was 8 (16%) and 42 (84%) respectively.

Computed test statistic in case of preoperative visual acuity and postoperative visual acuity both uncorrected and best corrected were higher than table value. .

In present study, striate keratitis was observed in 14% patients and Uveitis in 6% patients. Both these complications were got corrected by the end of one week.

Conclusion

Investigations in our study provides the assessment that average age of cataract were in mid 50's, male population (28 / 56%) was more than females (22 / 44%), preoperative astigmatism up to 1 D in 80% patients, and SIA considerably reduced on week- 6 interval and best corrected visual acuity (6/12 to 6/6) in 84% patients.

References

- Rainer G, Menapace R, Vaas C, *et al*. Corneal Shape Changes after Temporal and Superolateral 3.0 mm Clear Corneal Incisions. *J Cataract Refract Surg* 1999; 25: 1121-26.
- Jackson TL. Moorfields Manual of Ophthalmology. Mosby Elsevier, 2008; Philadelphia, 6.
- Moon SC, Mohamed T, Fine IH. Comparison of surgically induced astigmatism after clear corneal incision of different sizes. *Korean J Ophthalmology* 2007; 31:1-5.
- Altan-Yaycioglu R, Akova YA, Akra S, *et al*. Effect on astigmatism of the location of clear corneal incision in phacoemulsification of cataract. *J Refract Surg* 2007; 23:515-18.
- Tejedor J, Murube J. Choosing the location of corneal incision based on pre-existing astigmatism in phacoemulsification. *Am J Ophthalmol* 2005; 139:767-76.
- Tadros A, Habib M, Tejwani D, *et al*. Opposite clear corneal incision on the steep meridian in phacoemulsification: Early effects on the cornea. *J Cataract Refract Surg* 2004; 30:414-17.
- Sawhney S, Aggarwal A. SIA Calculator Version 2.1. A free software program approved by All India Ophthalmological Society (AIOS).
- Prasad S. Elements of Biostatistics. First Edition Rastogi Publications; Reprint (2003), ISBN 81-7133-613-2.
- Reddy B, Raj A, Singh VP. Site of incision and corneal astigmatism in conventional SICS versus phacoemulsification. *Ann Ophthalmol* 2007; 39 (3):209-16.
- Gokhle NS, Sawhney S. Reduction in astigmatism in manual small incision cataract surgery through change of incision site. *Indian J Ophthalmol* 2005; 53 (3):201-03.
- Roman SJ, Auclin FX, Chong Sit DA, *et al*. Surgically induced astigmatism with superior and temporal incision in cases of with-the-rule preoperative astigmatism. *J Cataract Refract Surg* 1998; 24 (12):1636-41.
- Madhu M, Raj VK. A study on postoperative corneal astigmatism in superior and temporal sections of sclera pocket small incision cataract surgery. *AIOC* 2006; Proceedings:328-31.
- Mukherji S, Kamath PA, Parihar JKS and Bandyopadhyay S. Temporal SICS: Practical advantages and great results at low cost- our experience. *AIOC*, 2007; Proceedings:127-30.
- Nichamin LD. Astigmatism control. *Ophthalmol Clin North Am* 2006; 19(4):485-93.
- Ferrer-Blasco T, Montes-Mico R, Peixoto -de-Matos SC, *et al*. Prevalence of corneal astigmatism before cataract surgery. *J Cataract Refract Surg* 2009; 35(1):70-5.
- Khan MI, Muhtaseb M. Prevalence of corneal astigmatism in patients having routine cataract surgery at a teaching hospital in the United Kingdom. *J Cataract Refract Surg* 2011;37(10):1751-5.
- Khokhar S, Lohiya P, Muurugiesan V. Corneal astigmatism correction with opposite clear corneal incision or single clear corneal incision: comparative analysis. *J Cataract Refract Surg* 2006;32(9):1432-7.
- Chayet A, Sandstedt C, Chang S, *et al*. Use of the light-adjustable lens to correct astigmatism after cataract surgery. *Br J Ophthalmol* 2010; 94(6):690-2.
- David SC, Patrick H. Prevalence of corneal astigmatism in an NHS cataract surgery practice in Northern Ireland. *Ulster Med J* 2017;86(1)25-27.
- Gaide SP and Khaire BS. Comparison of surgically induced astigmatism and postoperative astigmatism with superior, superotemporal and temporal incisions in phacoemulsification surgery. *International J Recent Trends in Science & Technology* 2014; 12(3):517-21.
- Marek R, Klus A and Pawlik R. Comparison of surgically induced astigmatism of temporal versus superior clear corneal incisions. *Klin Oczna* 2006;108:392-96.
- Simsek S, Yasar T, Demirok A, *et al*. Effect of superior and temporal clear corneal incisions on astigmatism after suture less phacoemulsification. *J Cataract Refract Surg* 1998;24(4):5515-18.