e-ISSN: 0976-822X, p-ISSN:2861-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(4); 248-255

Original Research Article

Hospital-Based Research to Estimate the Postoperative Astigmatism after Small‑Incision Cataract Surgery (SICS)

Bidisha Rani[1], Kaushal Kishore Mishra[2], Arun Kumar Sinha[3]

[1]Senior Resident, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

[2]Senior Resident, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

[3]Professor and HOD, Department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

Received: 19-01-2023 / Revised: 28-03-2023 / Accepted: 14-03-2023

Corresponding author: Dr. Kaushal Kishore Mishra

Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to estimate the postoperative astigmatism after small‑incision cataract surgery (SICS) done at the end of 1 and 3 months.

Methods: The present study was conducted at Bhagwan Mahavir Institute of Medical Sciences for 10 months and total of 100 patients were included in this observational longitudinal study. These patients underwent manual SICS with implantation of Posterior chamber intraocular lens (PCIOL).

Results: The age group 70–79 had the highest frequency 40% followed by 60-69 years 34%. 90% patients had 0.00-1.00 astigmatism and 75% had WTR type of astigmatism. In the current study, patients with mature senile cataract and immature senile cataract, fulfilling the inclusion criteria were selected. The observations achieved showed a maximum of 45 (45%) patients with NO II, followed by 35 (35%) with NO III, 15 (15%) with Mature senile cataract (MSC), and 6 (6%) with NO IV. The patients with a lesser length of incision had lesser SIA, as these incisions were present in the astigmatically neutral funnel. The average distance from the limbus that is considered normal is 1–1.5 mm. In the present study, there were 60 (60%) patients with distance from limbus ≤1.0 mm, while 30 (30%) had distance ranging between 1.1 and 1.5 mm and 10 (10%) had distance ≥1.5 mm.

Conclusion: We concluded that SIA is directly related to the length of incision, distance from the limbus, and suturing techniques. The SIA estimated in resident‑operated SICS cases was found to be between 1.75 and 2.5 D at the end of 1 and 3 months. SICS induces less surgically induced astigmatism, less inflammation, less complications influencing the overall visual prognosis and quick stabilization of refraction, hence providing better and rapid visual rehabilitation in the postoperative period.

Keywords: Keratometry, SICS, Surgically Induced Astigmatism.

Introduction

Senile cataract is most important cause of reversible blindness in India and other developing countries. [1] Now-a-days, all techniques of cataract extraction are being modified to give best uncorrected visual acuity and early rehabilitation. [2] In the same race conventional Extra Capsular

Cataract Extraction (ECCE) was improved to manual Small Incision Cataract Surgery (SICS) and Phacoemulsification. The disadvantages of conventional large incision ECCE is that technically it is more difficult to make large incisions. It is exposed to increased risks of expulsive hemorrhage, difficulty in suturing while closing the section. Postoperatively large incisions are associated with more inflammation and suture induced problems such as astigmatism and irritation. Refraction remains changing for many months postoperatively and induced astigmatism is more, thereby resulting in delayed and unsatisfactory visual rehabilitation. Though phacoemulsification has emerged as "state of art", in the developing countries, the cost and the maintenance factor put it beyond the availability to most patients. Thus many surgeons world over are considering "Manual small incision cataract surgery-SICS", which is cost effective, safe with low postoperative inflammation, requiring fewer visits for follow up care. Due to earlier stabilization of refraction and less surgically induced astigmatism (SIA) visual rehabilitation is quick and satisfying. Furthermore astigmatically neutral incisions can be performed to counter any preexisting astigmatism, making this technique both a therapeutic and a refractive procedure. Small incision sutureless cataract surgery permits high volume, high quality, low cost surgeries with speed and safety and hence holds major importance in rural centers especially in developing countries facing enormous surgical volumes and limited resources. [3]

Cataract surgery is considered equivalent to refractive surgery as the patient demands spectacle‑free vision after surgery. [4] Astigmatism has a major influence on vision quality, and surgical technique as well as surgeon expertise play an important role. The occurrence of surgically induced astigmatism (SIA) varies from 7.50% to 75% based on the surgical technique and skill of the surgeon. Also, 25%–30% of eyes have clinically significant astigmatism (>2 D) requiring correction. [5] Cataract surgery training forms the mainstay of the residency teaching program. Hence, obtaining proficiency and skills in cataract surgical techniques is one of the most important elements of the resident training program in ophthalmology. Training of postgraduate medical students is the basis for all the medical specialty training and is more important in ophthalmic surgeries because of a longer learning curve. [6,7] To keep up with the technological advances in phacoemulsification and toric intraocular lenses (IOLs), the budding ophthalmologists should be trained to know and understand SIA during their dynamic residency programme.

The aim of the present study was to estimate the postoperative astigmatism after small‑incision cataract surgery (SICS) done at the end of 1 and 3 months.

Materials and Methods

The present study was conducted at department of Ophthalmology, Bhagwan Mahavir Institute of Medical Sciences and total of 100 patients were included in this observational longitudinal study. These patients underwent manual SICS with implantation of Posterior chamber intraocular lens (PCIOL). All surgeries were supervised by a single surgeon. All patients in this study were operated and followed up. The Institutional Ethics Committee approved the study protocol, patient information sheet, and consent form. All the patients gave their written informed consent.

Inclusion criteria

1. Patients of mature and immature senile cataract with lens opacities classification system (LOCS) III grading of NO 1/NO 2/NO 3/NO 4 ± cortical ± posterior subcapsular cataract (PSC).

2. SICS surgeries performed.
3. All surgeries supervised by a single surgeon.

Exclusion criteria

1. Patients with previous intraocular surgeries, for example, keratoplasty
2. Patients with preexisting astigmatism >2 D
3. Patients with corneal opacity, pterygium
4. Previous diabetic or hypertensive retinopathy or age‑related macular degeneration
5. Complicated cataract

All the patients underwent detailed ocular and systemic examinations.

Thorough preoperative evaluation was done, which included history, uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), anterior segment examination, and slit‑lamp examination. Posterior segment evaluation was done using a 90 D lens on a slit lamp and an indirect ophthalmoscope with a 20 D lens.

Cataract grading was done according to LOCS III.

The autokeratometer (GR‑3300K) was used for keratometry, and the Biomedix A ‑scan machine was used for axial length measurement and biometry. The IOL power was calculated using the Sanders-Retzlaff-Kraff (SRK) II formula. The lens was selected in such a way that a postoperative refractive error of −0.25 to −0.50 D was achieved, with an A‑constant of 118.0. Along with these, the keratometric readings of the patient were taken preoperatively, which included K1 (horizontal), K2 (vertical), A1 (horizontal axis), and A2 (vertical axis).

Using a coaxial microscope, all procedures were conducted by Senior residents under the direction of a single experienced surgeon.

The lid and periorbital area were cleaned with 5% povidone solution. Superior rectus bridle suture was placed. Superior scleral incision of length 6.5–7.5 mm was made using Bard Parker handle and 15 no. blade. The incision length was measured with Castroviejo's caliper. A straight incision was made 1–1.5 mm away from the limbus as per the convenience of the operating surgeon. Sclerocorneal tunnel and side port were created. Anterior capsulorrhexis was done using 26G cystotome. 3.2 mm keratome was used to enter the anterior chamber through tunnel. Hydrodissection and delineation were performed. A single‑piece polymethyl methacrylate (PMMA) intraocular lenses with 6 mm optic diameter was put in the capsular bag and dialed. The anterior chamber was constructed, and the incision was closed with a single 10‑0 nylon suture either cross or vertical, according to the operating surgeon's surgical competence.

Postoperatively, patients were followed up on day 7, 1 month after surgery, and 3 months following surgery.

Patients were assessed for the following parameters on all follow‑ups:

1. UCVA
2. BCVA
3. Detailed slit‑lamp examination
4. All the parameters: K1, K2, A1, A2 were calculated on autokeratometer (GR‑3300K) postoperatively at 1 and 3 months.
5. Calculation of SIA was done using Hill's SIA calculator version 2.0 working according to the vector analysis method.

Results

Table 1: Distribution of age

Age groups	N%
30–39	4 (4)
40–49	5 (5)
50–59	10 (10)
60–69	34 (34)
70–79	40 (40)
80–89	7 (7)
Total	100 (100)

The age group 70–79 had the highest frequency 40% followed by 60-69 years 34%.

Table 2: Preoperative Astigmatism Distribution and Pattern of Study Subjects

Astigmatism	N%
0.00-1.00	90 (90)
1.25-2.00	10 (10)
Type of Astigmatism	
WTR	75 (75)
ATR	10 (10)
Nil	15 (15)

90% patients had 0.00-1.00 astigmatism and 75% had WTR type of astigmatism.

Table 3: Distribution of patients as per the diagnosis

Diagnosis	*n*	%
MSC	15	15
Nuclear opacification ± cortical ± posterior subcapsular cataract	45	45
NO 3±C ± P	35	35
NO 4±C ± P	6	6
Total	100	100

In the current study, patients with mature senile cataract and immature senile cataract, fulfilling the inclusion criteria were selected. The observations achieved showed a maximum of 45 (45%) patients with NO II, followed by 35 (35%) with NO III, 15 (15%) with Mature senile cataract (MSC), and 6 (6%) with NO IV.

Table 4: Length of incision: an average of keratometric readings – preop, at 1 and 3 three months, and P-values

Stage and parameter	Length of incision (mm)									*P#*
	≤7			7.1–8.0			>8.0			
	n	Mean	S.D.	*n*	Mean	S.D.	*n*	Mean	S.D.	
Preoperative K1	70	42.98	1.44	20	45.3	1.55	10	43.7	1.42	**0.01**
Postoperative K1	70	43.77	1.49	20	42	1.45	10	45.5	1.15	0.11
*P**		**<0.0001**				**<0.0001**			0.077	
Preoperative K2	70	45.5	1.45	20	46.5	1.14	10	45.5	0.55	**0.025**
Postoperative K2	70	44.12	1.4	20	44.8	0.85	10	46.4	0.85	0.34
*P**	70		0.25	20		**0.007**			0.22	
Preoperative A1	70	83.16	38.12	20	92.2	34.24	10	74.6	36.04	0.62

Postoperative A1	70	94.36	34.36	20	110	29.36	10	115.4	50.6	0.33
*P**	70		0.08	20		0.23			0.235	
Preoperative A2	70	78.82	65.35	20	44.7	60.5	10	54.2	65.85	0.346
Postoperative A2	70	50.48	50.55	20	25.6	28.32	10	61.4	50.55	0.28
*P**	70		**0.042**			0.332			0.874	
SIA 1 month	70	1.9	0.61	20	2.9	0.38	10	3.7	0.28	**<0.0001**
SIA 3 months	70	1.7	0.61	20	2.48	0.46	10	2.8	0.4	**<0.0001**
*P**		**<0.0001**				**0.01**			**0.016**	

The distribution according to the length of incisions was as follows: 70 (70%) patients having length ≤7.0 mm, while 20 (20%) had it between 7.1 and 8.0 mm, and 10 (10%) had a length of more than 8 mm. Average SIA for patients with a length of incision ≤7 mm at the end of 1 and 3 months was 1.95 and 1.76 D, respectively, which was the least in the various groups in the study. However, 10% of patients had the length of incision >8 mm, which resulted in a maximum SIA of 3.2 and 2.9 D at the end of 1 and 3 months, respectively. Thus, the patients with a lesser length of incision had lesser SIA, as these incisions were present in the astigmatically neutral funnel.

Table 5: Distance from the limbus: an average of keratometric readings – preop, at 1 and 3 months and P values

Stage and parameter	**Distance from the limbus (mm)**									***P#***
	≤1.0			**1.1-1.5**			**>1.5**			
	n	**Mean**	**S.D.**	***n***	**Mean**	**S.D.**	***n***	**Mean**	**S.D.**	
Preoperative K1	60	42.88	1.6	30	44.06	1.55	10	44.8	2.08	0.385
Postoperative K1	60	42.95	1.6	30	45.05	1.58	10	43.7	1.19	0.525
*P**		**<0.0001**			**0.02**			0.69		
Preoperative K2	60	47.44	1.6	30	46	1.27	10	45.4	0.65	0.292
Postoperative K2	60	46.84	1.4	30	47.63	1.09	10	45.5	0.55	0.094
*P**		0.19			0.57			0.955		
Preoperative A1	60	82.5	39	30	87.33	35.2	10	67.8	71.8	0.62
Postoperative A1	60	98.12	36	30	100.94	30.4	10	129	42.2	0.27
*P**		0.105			0.235			0.09		
Preoperative A2	60	66.34	63	30	80.2	72.1	10	65.8	67.6	0.74
Postoperative A2	60	55.15	52	30	39.93	52.4	10	39.3	42.2	0.635
*P**		0.32			0.09			0.51		
SIA 1 month	60	1.85	0.5	30	2.58	0.55	10	3.18	0.5	**<0.0001**
SIA 3 months	60	1.65	0.6	30	2.22	0.52	10	2.5	0.4	**<0.0001**
*P**		**<0.0001**			**<0.0001**			0.123		

The distance from the limbus and astigmatism are inversely proportional. Even though, placing the incision farther posteriorly makes the procedure more difficult by lengthening the tunnel and restricting the movement of the instruments. Posterior placement of incision causes difficulty in the maneuvers. The average distance from the limbus that is considered normal is 1–1.5 mm. In the present study, there were 60 (60%) patients with distance from limbus ≤1.0 mm, while 30 (30%) had distance ranging between 1.1 and 1.5 mm and 10 (10%) had distance ≥1.5 mm.

Discussion

Cataract contributes to 47.8%–51.0% of blindness globally. [8] This load being great in developing nations, desirable “phacoemulsification for all” is neither practical nor achievable. Due to cheaper cost of instruments and disposables, small ‑incision cataract surgery (SICS) seems to be the silver lining in the phacoemulsification era for addressing the cataract load in developing countries. [9] It also works better for mature and advanced cataracts, which are more common in these nations. [10]

Placing incisions on the steeper corneal meridian has been recommended during SICS with the idea that there is flattening of the meridian on which the incision is placed. [11,12] Hence, with an on-axis incision, there is a reduction in the corneal power of the steeper meridian because of the flattening effect of the incision leading to minimal postoperative corneal astigmatism. For patients with ATR astigmatism who have a flatter vertical corneal meridian, it would be expected that a superior approach SICS would flatten the already flatter vertical meridian leading to high postoperative corneal astigmatism. With senile cataract being the most common type of cataract in developing countries1 and since there is an ATR shift in astigmatism with age [13], most cataract patients in developing countries may have preoperative ATR astigmatism. The choice of the location of incision for these groups of patients is therefore very important as that can influence the amount of postoperative corneal astigmatism.

90% patients had 0.00-1.00 astigmatism and 75% had WTR type of astigmatism. The preoperative astigmatism is important in the final postoperative astigmatism outcome, because cornea has the tendency for natural recovery to the preoperative curvature which in interaction with SIA component affects a change in the final postoperative astigmatism status. The size and location of the incision have a profound impact on the postoperative visual results. Induced astigmatism is directly proportional to the cube of incision length and inversely proportional to the distance the incision is placed from the limbus. [14] Burgansky et al have shown an increase in astigmatism with an increase in incision size. [15] Kimura et al have shown by vector analysis that surgically induced astigmatism is less with an oblique incision (1.02 + 0.66 D) than with a superior incision (1.41 + 0.72 D). [16] The incision in the SICS group is 6mm against the 10-12mm in the ECCE group and is about 1mm away from the limbus compared to the ECCE group where the incision is just on the limbus. The results we got are quite compatible with this fundamental principle.

Scleral incisions have other advantages over clear corneal incisions like fewer chances of endophthalmitis, less glare, less wound sagging and dehiscence and irregular astigmatism. [17] Further superior approach incisions which we have employed are comparable to temporal approach in terms of visual rehabilitation and induced astigmatism. [18] Sutureless incisions when constructed properly and adequately prove to be stable incisions that resist leakage and iris prolapse at intraocular pressure of over 400mmHg (Hydrostatic) as these incisions are self sealing because pressure in the anterior chamber automatically pushes the lip against the intracorneal portion of the incision sealing it tightly without sutures. [19] Other advantages are absence of hyphemas and foreign body sensation from sutures, no damage to the ciliary body by suture needles and increased stability of the wound.

Haldipurkar et al [20] in 2009, described and performed a vector analysis of the wound construction strategies and parameters in SICS. Properties of a reliable self‑sealing incision were also illustrated. They also demonstrated that all the incisions if placed 1–1.5 mm from the limbus on the sclera induce less astigmatism. But they also reported that more posterior incisions (>1.5 mm) would make it difficult to handle the instruments while performing surgery as they will increase the tunnel length. In 2017, Eslami and Mirmohammadsadeghi [21] in their prospective, nonrandomized, comparative trial, compared SIA between cross and horizontal sutures in a scleral incision in SICS. The SIA was calculated at 1 and 3 months postoperatively and it was concluded that cross sutures were preferred in SICS as they caused ith the rule astigmatism. Studies similar to the current study conducted by Yoo and Lee [22] in 2018 showed that the astigmatism present after interrupted suturing was greater, especially in the early postoperative period. However, the astigmatism caused by absorbable sutures in scleral tunnel cataract surgery was very transitory, disappearing 4 weeks after surgery. [23]

The pattern of induced astigmatism continues to be almost uniform during all the follow up visits i.e. the surgical shift in axis continues to remain by and large unaltered especially the unconventional shifts with the conventional shifts in some patients returning gradually to neutral axes resulting in astigmatic neutrality. The WTR shift in ECCE continues to decrease as the sutures get slowly absorbed and the surgical scar tends to relax causing a mild slowly progressive flattening along the vertical meridian so as to restore the preoperative curvature. In the SICS group the ATR shift also decreases gradually as the wound lips start apposing and the wound gap tends to scar and contracts resulting in mild progressive steepening along the vertical meridian in an attempt to attain the preoperative curvature.

Conclusion

We concluded that SIA is directly related to the length of incision, distance from the limbus, and suturing techniques. The SIA estimated in resident-operated SICS cases was found to be between 1.75 and 2.5 D at the end of 1 and 3 months. SICS induces less surgically induced astigmatism, less inflammation, less complications influencing the overall visual prognosis and quick stabilization of refraction, hence providing better and rapid visual rehabilitation in the postoperative period. The high postoperative corneal astigmatism may create blurred images through a bigger circle of the least confusion on the retina.

References

1. Brian G, Taylor H. Cataract blindness: challenges for the 21st century. Bulletin of the World Health Organization. 2001; 79:249-56.
2. Venkatesh R, Das M, Prashanth S, Muralikrishnan R. Manual small incision cataract surgery in eyes with white cataracts. Indian J Ophthalmol. 2005; 53(3):173-6.
3. Gogate PM, Deshpande M, Wormald RP. Is manual small incision cataract surgery affordable in the developing countries? A cost comparison with extra-capsular cataract extraction. Br J Ophthalmol. 2003 Jul; 87 (7):843–6.
4. Pandey SK, Sharma V. Cataract surgery training during ophthalmology residency in India: Challenges and how to overcome them?. Indian Journal of Ophthalmology. 2017 Dec;65(12):127 9.
5. Anderson DF, Dhariwal M, Bouchet C, Keith MS. Global prevalence and economic and humanistic burden of astigmatism in cataract patients: a systematic literature review. Clinical Ophthalmology. 2018 Mar 6:439-52.
6. Tzamalis A, Lamprogiannis L, Chalvatzis N, Symeonidis C, Dimitrakos S, Tsinopoulos I. Training of resident ophthalmologists in cataract surgery: a comparative study of two approaches. Journal of Ophthalmology. 2015 May 14;2015.
7. Biswas P, Gogate PM, Maskati QB, Natarajan S, Verma L, Bansal PK. Residency Evaluation and Adherence Design Study III: Ophthalmology residency training in India: Then and now–Improving with time?. Indian

Journal of Ophthalmology. 2018 Jun 1; 66(6):785-92.

8. Hussen MS, Gebreselassie KL, Seid MA, Belete GT. Visual outcome of cataract surgery at Gondar University Hospital Tertiary Eye Care and Training Center, Northwest Ethiopia. Clinical Optometry. 2017 Jan 10:19-23.
9. Thomas R. Role of small incision cataract surgery in the Indian scenario. Indian Journal of Ophthalmology. 2009 Jan;57(1):1.
10. Jauhari N, Chopra D, Chaurasia RK, Agarwal A. Comparison of surgically induced astigmatism in various incisions in manual small incision cataract surgery. International journal of ophthalmology. 2014;7(6):1001.
11. Nielsen PJ. Prospective evaluation of surgically induced astigmatism and astigmatic keratotomy effects of various self-sealing small incisions. Journal of Cataract & Refractive Surgery. 1995 Jan 1;21(1):43-8.
12. Nanevicz TM, Prince MR, Gawande AA, Puliafito CA. Excimer laser ablation of the lens. Archives of Ophthalmology. 1986 Dec 1;104 (12): 1825-9.
13. W. M. Lyle, "Changes in corneal astigmatism with age," Optometry & Vision Science, vol. 48, no. 6, pp. 467–478, 1971.
14. Ravi Thomas, Aby Jacob, Thomas George. Small incision cataract surgery. Recent advances in Ophthalm ology, HV Nema 1996; 3: 57-74.
15. Burgansky Z, Isakov I, Avizemer H, Bartov E. Minimal astigmatism after sutureless planned extracapsular cataract extraction. J Cataract Refract Surg. 2002 Mar;28(3):499-503. [Pub Med]
16. Kimura H, Kuroda S, Mizoguchi N, Terauchi H, Matsumura M, Nagata M. Extra-capsular cataract extraction with a sutureless incision for dense cataracts. J Cataract Refract Surg. 1999 Sep;25(9):1275-9.
17. Richard L. Lindstrom. Control of Astigmatism in the cataract patient. Cataract surgery- technique, complications and management. Steinert 1995; 232.
18. Oshika T, Sugita G, Tanabe T, Tomidokoro A, Amano S. Regular and irregular astigmatism after superior versus temporal scleral incision cataract surgery. Ophthalmology 2000 Nov;107 (11):2049-53. [PubMed]
19. Ernest PH, Lavery KT, Kiessling LA. Relative strength of scleral tunnel incisions with internal corneal lips constructed in cadaver eyes. J Cataract Refract Surg. 1993 Jul;19(4):457-61.
20. Haldipurkar SS, Shikari HT, Gokhale V. Wound construction in manual small incision cataract surgery. Indian J Ophthalmol 2009; 57:9‑13.
21. Eslami Y, Mirmohammadsadeghi A. Comparison of surgically induced astigmatism between horizontal and X-pattern sutures in the scleral tunnel incisions for manual small incision cataract surgery. Indian journal of ophthalmology. 2015 Jul;63(7):606.
22. Yoo JH, Lee SJ. The effect of suture by absorbable material on corneal astigmatism after phacoemulsification. Kosin Medical Journal. 2018 Dec 31; 33(3):318-27.
23. El Marnissi, S., Eljaoudi, R., Bousliman, Y., & Ait El Cadi, M. Dosage des Inhibiteurs de la calcineurine en Transplantation rénale. Journal of Medical Research and Health Sciences, 2023;6(4): 2490–2502.