

## To study the effect of limbal relaxing incision on pre existing astigmatism in SICS cataract surgery

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### Abstract

**Aim:** To assess pre-existing astigmatism and to evaluate the effect of limbal relaxing incision on pre-existing astigmatism post-operatively in patients undergoing SICS cataract surgery.

**Materials and Methods:** The study was conducted in the Department of Ophthalmology at Nehru Hospital attached to B.R.D. Medical College, Gorakhpur from period of July 2016 to June 2017.

**Study Design:** This study is a comparative observational study. All the surgeries were performed by one surgeon.

**Study Group:** patients meeting the inclusion criteria i.e. 1-3 D astigmatism as per keratometric readings.

**Results:** A total of 90 patients were included in the study. Mean age  $58.19 \pm 7$  years (range 30-70yrs). Mean pre-operative astigmatism of  $1.44 \pm 0.39$ D was found in these patients. Data analyzed demonstrated statistically significant reduction in the mean post-operative day 30 astigmatism in the LRI group to  $0.54 \pm 0.34$  D (range: 0 to 2.5) from  $1.31 \pm 0.38$  D (range: 1 to 3 D) preoperatively as compared to control group to  $1.19 \pm 0.56$  D (range: 0 to 2.5) from  $1.57 \pm 0.37$  D (range: 1 to 3 D) preoperatively, p-value 0.0001. There were no intraoperative complications or postoperative subjective complaints in our patients.

**Conclusion:** Limbal relaxing incisions performed during SICS cataract surgery appear to be effective as well as safe procedure to reduce pre-existing corneal astigmatism.

**Keywords:** LRI, SICS, Cataract, Astigmatism.

### Introduction

India is one of the countries with the largest number of Cataract blindness. Hence it was not surprising that the Cataract surgery has increased exponentially in this country. It was estimated that, 15–20% of individuals undergoing cataract surgery have greater than 1.5D of cylinder of pre-operative astigmatism.<sup>1</sup> The goal of Cataract surgery in recent years as to achieve a desirable refractive outcome with minimal induction of astigmatism after cataract surgery. So the outcome of cataract surgery with minimum residual astigmatism depends on the factors that effects Surgically Induced Astigmatism (SIA). Surgically induced astigmatism solely depends on the surgeon's skills, the site and type of incision given and greatly depends on the amount of pre-existing corneal astigmatism. Newer techniques developed to reduce the effect of pre-operative corneal astigmatism these includes toric intraocular lens implants (tIOL) or postoperative vision correction by ablative refractive surgery by excimer laser, clear corneal incisions (CCI); each with its own advantages and disadvantages.<sup>2-4</sup> Due to a number of factors like corneal thickness, corneal tissue elasticity, and limbus size yield results that are not always repeatable and causes varying corneal response. There are different LRI nomograms which considers the amount and type of astigmatism and the patient's age. After a learning curve, every surgeon adapts his or her technique to the nomogram. Limbal

relaxing incisions produce good results up to about 4.00 D of astigmatism.<sup>5</sup>

In this study we documented the efficacy and safety for correction of pre-existing corneal astigmatism (1-3D) by limbal relaxing incisions (LRIs) during SICS cataract surgery.

### Materials and Methods

The study was conducted in the Department of Ophthalmology at Nehru Hospital attached to B.R.D. Medical College, Gorakhpur from period of July 2016 to June 2017, for a duration of one year.

**Study Design:** This study is a comparative observational study. All the surgeries were performed by one surgeon. **Study Group:** patients who meets the inclusion criteria i.e. 1-3 D astigmatism.

**Inclusion Criteria:** Patients enlisted for small incision cataract surgery with coexisting astigmatism between 1D to 3D was recruited. Eyes that underwent SICS cataract surgery with limbal relaxing incisions (test group) and eyes that underwent SICS cataract surgery only (control group). All patients (30yrs to 70 yrs) underwent a complete external ophthalmic examination that included

1. uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA)
2. anterior segment slit – lamp examination to rule out any anterior segment pathology,
3. fundus examination and

4. keratometry was performed to measure the curvature of the cornea and to determine astigmatism of 1D to 3 D.
5. Patients were evaluated at 1st day, 7<sup>th</sup> day and 30<sup>th</sup> day postoperatively.
6. Post-operative examination included UCVA, BCVA, anterior segment slit-lamp microscopy and keratometry to find reduction in astigmatism.

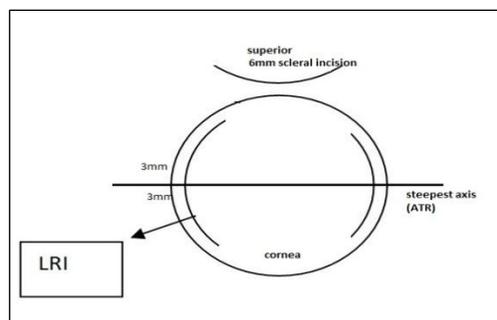
**Exclusion Criteria:**

1. Corneal opacity, degeneration or dystrophies
2. Pterygium, irregular astigmatism
3. Glaucoma.
4. Macular pathology
5. Any retinal vascular disease, retinopathy or retinal detachment
6. Patients with any other ocular or ocular related systemic co-morbidity.

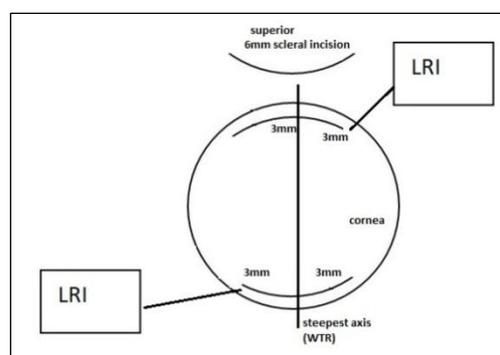
An informed consent for administration of medication and surgery was taken.

**Intraocular lens (IOL) Calculation:** SRK-T formula and Hoffer Q was used for axial length with <22 and >24.5, SRK-II and Holladay II for other patients for IOL power calculation.

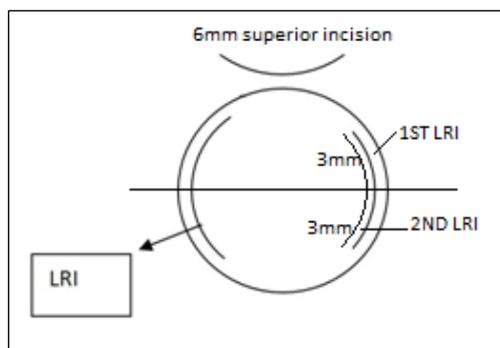
**Surgical Steps:** All cataract surgeries was performed through a superiorly placed 6 mm SICS scleral incision (triplanar). IOL implantation was accomplished by rigid PMMA lens. Disposable knives with carbon steel blade of preset length of 550µm was used to perform the LRIs. A) For eyes with ATR astigmatism of 1 D, the following steps was carried out: 1) the nasal arc of the 6mm LRI, taking 3mm naso-superiorly and 3mm naso-inferiorly on the steepest axis of the eye was made in the clear cornea close to the limbus (approximately 0.5 mm). 2). The temporal arc of 6mm LRI, taking 3mm tempo-superiorly and 3mm tempo-inferiorly on the steepest axis of the eye were made, Fig. 1. B) For ATR astigmatism  $\geq 2D$ ; another 6 mm LRI incision , 3 mm superiorly and 3mm inferiorly was made 0.5mm inward to the 1st 6mm LRI incision given , was made to correct 1D of surgical induced astigmatism (SIA) in SICS cataract surgeries Fig. 3. C) for WTR astigmatism an inferior 6mm LRI arc was made on clear cornea, taking 3mm inferio- nasally and 3mm inferio –temporally on the steep axis (approximately 0.5 mm from limbus). Considering the surgical flattening of vertical axis about 0.5D in Phaco and 1D in SICS was obtained, Fig. 2.



**Fig. 1: 6 mm SICS incisión in sclero corneal junction with 6 mm LRI incision with nasal arc and temporal arc was made approximately 0.5 mm away from limbus in clear cornea (1D ATR astigmatism)**



**Fig. 2: Superior arc and inferior arc of 6 mm LRI incision in WTR astigmatism**



**Fig. 3: 2<sup>nd</sup> LRI incision was given 0.5mm inward to the 1<sup>st</sup> LRI incision for reducing 1 D of SIA in  $\geq 2D$  ATR astigmatism**

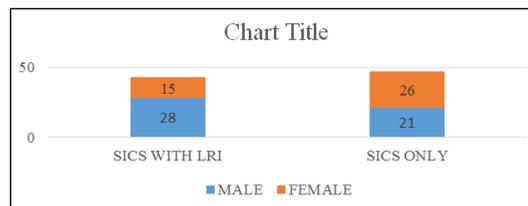
The success of this procedure was evaluated by comparing pre- and post-operative keratometry readings on each visit i.e. on post-operative day1, day7 and day30. Comparing the arithmetic mean and standard deviation of the post-operative keratometric astigmatism between the two groups obtained the effectiveness of LRIs in reducing the pre-existing astigmatism as compared to SICS only t-test was used to check the difference between the two groups with level of significance of  $\leq 0.0001$ . All post-operative complications and subjective symptoms were recorded

and there were no observed post-operative complications in the patients.

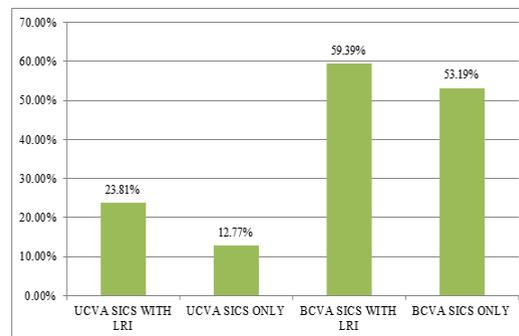
no intraoperative complications or postoperative subjective complaints in our patients.

**Results**

A total of 90 patients were included in the study. Out of 90 patients 43 patients were included in SICS with LRI group (test group) where 15 were females and 28 were males whereas in the control group (SICS only) 47 patients were included in which 26 were females and 21 were males, Table 1, Fig. 4. Mean age group was  $58.19 \pm 7$ (range 30-70). Mean pre-operative astigmatism was found to be  $1.44 \pm 0.39$ (range: 1 to 3 D). The pattern of astigmatism was found to be ATR astigmatism to be 77.78% and WTR stigmatism 22.22%, Table 2. The prevalence of ATR was seen to be more than WTR astigmatism. The mean pre-operative astigmatism in test group (LRI) was  $1.31 \pm 0.38$  D and mean reduction in post-operative astigmatism on day 30 was  $0.54 \pm 0.34$  D. While the mean pre-operative astigmatism in control group was  $1.57 \pm 0.37$  D and mean reduction in post-operative astigmatism on day 30 was  $1.19 \pm 0.56$  D, p-value  $\leq 0.0001$ , Table 4. The best corrected vision with  $\leq 0.50$  D cylinder with test group (LRI) obtained 6/6-6/9 on 1 month post-operatively was 59.39% while for control group (SICS) was 53.19%, Table 5, Fig. 5. There were



**Fig.4: Gender Distribution**



**Fig. 5: Visual acuity at post-operative day 30 obtaining 6/6-6/9**

**Table 1: Gender distribution and number of patients undergoing the study**

Groups	Male	Female	No. of Patients
SICS With LRI (Test Group)	28	15	43
SICS Only(Control Group)	21	26	47
Total	49	41	90

**Table 2: Number of patients with pre-operative astigmatism**

Groups	ATR	%	WTR	%	Total
SICS with LRI	31	72.09%	12	27.91%	43
SICS Only	39	82.98%	8	17.02%	47
Total	70	77.78%	20	22.22%	90
					100%

**Table 3: Keratometry readings in pre-operative astigmatism**

Group	No. of Patients	Pre-op Mean $\pm$ S.D.	Post-op D30 Mean $\pm$ S.D.
SICS With LRI	43	K1= 44.27 $\pm$ 1.35 K2= 44.89 $\pm$ 1.65	K1= 44.66 $\pm$ 1.20 K2= 44.83 $\pm$ 1.53
SICS Only	47	K1= 43.94 $\pm$ 1.58 K2= 45.03 $\pm$ 1.81	K1= 44.40 $\pm$ 1.52 K2= 45.06 $\pm$ 1.53

**Table 4: Mean reduction of post-operative astigmatism on day 30**

Group	Pre-operative astigmatism (Mean)	Post-operative Astigmatism (Mean)
SICS with LRI	$1.31 \pm 0.38$	$0.54 \pm 0.34$
SICS only	$1.57 \pm 0.37$	$1.19 \pm 0.56$

**Table 5: Visual acuity at post-operative Day 30**

Visual Acuity	SICS with LRI		SICS only	
	UCVA	BCVA $\leq 0.50D$	UCVA	BCVA $\leq 0.50D$
6/6-6/9	23.81%	59.39%	12.77%	53.19%
6/12-6/18	64.29%	28.71%	53.19%	34.04%
6/24-6/36	11.90%	11.90%	31.91%	12.77%
6/60 or less	0	0	2.13%	0

## Discussion

Goal of cataract surgery is to achieve a desirable refractive outcome with reduction in pre-operative astigmatism after surgery. Visual recovery who underwent cataract surgery is closely related to the use of appropriate IOL power calculation.<sup>6-8</sup>

LRI has been used to correct preexisting astigmatism during the time of cataract surgery. Simultaneously, one can benefit from low costs and easy performance with minimal learning curve, without overcorrection. However, the predictability, stability and range of correction are rather limited.

LRI causes less distortion and irregularity at the limbus and can provide more rapid postoperative visual acuity (VA) as compared to clear corneal incisions. According to Gills and Guyton suggested LRIs to be more effective in reducing low to moderate astigmatism (1-4D), rather than high astigmatism. Patients undergoing clear corneal incision reported post-operative glare and discomfort while LRI underwent patients did not report for the same.

Ferrer Blasco T et al<sup>9</sup> studied that corneal astigmatism <1D were present in most cataract surgery patient; it was higher in about 22%, slight differences between the various age ranges. They also observed in 13.2% had no corneal astigmatism, while in 64.4% showed corneal astigmatism between 0.25D and 1.25D and 22.2% had 1.5D or higher astigmatism.

The current study showed that the prevalence of ATR astigmatism (77.78%) more than WTR astigmatism (22.22%).

While Khan MI et al.<sup>10</sup> showed corneal astigmatism was  $\leq 0.50D$  in 301 eyes (24.47%),  $\leq 1.5D$  in 978 eyes (79.50%), and  $\geq 3.00D$  in 24 eyes (1.93%).

Astigmatism correction is evaluated by comparing the difference in K1 and K2 values, and the mean of pre-operative and postoperative keratometric values. By using mean and standard deviation of the post-operative astigmatism between the two groups the effectiveness of LRI was evaluated.

Under correction was not uncommon in previous reports.<sup>11,12</sup> A study done on 22 patients, they used the Gills nomogram for LRI during phacoemulsification and found 44% reduction in astigmatism, Budak et al,<sup>13</sup> while in another study of Budak et al, found 75% of patients out of 12 eyes were under corrected during phacoemulsification with LRI. Our study demonstrated that the use of LRIs during SICS cataract surgery significantly reduces corneal astigmatism.

Carvalho et al,<sup>6</sup> studied astigmatism using corneal topography where they concluded a statistically significant reduction in the mean topographic astigmatism in the cataract with LRI eyes from  $1.93 \pm 0.58 D$  preoperatively to  $1.02 \pm 0.60 D$  at 6 months postoperatively ( $p < 0.05$ ).

Mohammad Ali Zare et al,<sup>14</sup> study on Management of Corneal Astigmatism by Limbal Relaxing Incisions during Cataract Surgery showed the mean corneal

astigmatism was seen from  $1.9 \pm 0.83 D$  preoperatively to  $1.4 \pm 0.84 D$  and  $1.4 \pm 0.92$ , 2 months and 6 months postoperatively respectively ( $p < 0.001$ ).

Mehvash Hussain et al,<sup>15</sup> study the effectiveness of LRI during phacoemulsification in reducing corneal astigmatism and concluded that the mean post-operative astigmatism in the LRI group to  $0.73 \pm 0.71 D$  in the 3rd postoperative month from  $1.78 \pm 0.81 D$  preoperatively as compared to only phacoemulsification group to  $1.17 \pm 0.57 D$  post-operatively from  $1.28 \pm 0.41 D$  preoperatively p-value being 0.021.

While our study was conducted on SICS with LRI and SICS only, the mean post-operative astigmatism in the LRI group was  $0.54 \pm 0.34 D$  while in the control group was  $1.19 \pm 0.56 D$ . LRI group showed reduction in astigmatism from  $1.31 \pm 0.34D$  pre-operatively to  $0.54 \pm 0.34 D$  in the postoperative day 30 whereas the control group showed reduction in astigmatism from  $1.57 \pm 0.37 D$  preoperatively to  $1.19 \pm 0.56 D$  in the postoperative day 30. As evident from above discussion we can conclude that our study compares the effect of SICS with LRI and SICS only in reducing the pre-existing astigmatism in patients underwent Cataract surgery. This study was conducted on larger group of population therefore, statistically it is more significant.

The surgeon factor for under correction of astigmatism was reduced by performing all operations by only one surgeon in patients in both the groups. The type, site and depth of incision was another important factor for under correction as oblique incision rather than perpendicular incision on the limbus may result in the wrong depth causing under correction.<sup>16</sup> The placement of giving a limbal relaxing incision on clear cornea was also a factor for under correction, thus herein, we are placing LRIs 0.5 mm inside the limbus on cornea to maintain regularity in astigmatism of 1D and another LRI was given 0.5 mm inside to the previously given LRI (i.e. a total of 3 LRI) given along the steepest axis.<sup>18</sup> When combined with the accurate identification of the steep meridian of corneal astigmatism, limbal relaxing incisions are safe and efficacious for correcting corneal astigmatism during cataract surgery as in comparison to more number of central clear corneal incisions may cause more glare and higher order aberrations for the patients. LRIs benefits from being low cost and easy procedure requiring minimal learning curve, without overcorrection. However, the predictability, stability and range of correction are rather limited.

With the refinement of Cataract surgery to achieve best visual recovery with less post-operative discomfort and complications there developed several options to reduce the pre-operative astigmatism including intra-operative clear corneal incisions where patients may complain of post-operative glares due to high aberrations in the cornea. Toric IOL implantation is a better option in reducing high astigmatism  $>4D$ . However, if postoperative rotation of the tIOL occurs,

there would be a significant induced astigmatism as well as tIOL are expensive. Postoperative vision correction by ablative refractive surgery by excimer laser, has its own pros and cons. Excimer laser vision correction after cataract surgery needs an additional operation with high expenses, possible complication, especially in patients with pre-existing dry eyes complains and has a limitations in patients with thin cornea.

### Conclusion

The LRI incisions of 550 $\mu$ , 6mm were given on the steepest axis.

At the end of 1 month, in SICS with LRI 23.81% patients had 6/6-6/9 uncorrected visual acuity and 59.39% patients had best spectacle corrected visual acuity between 6/6- 6/9 while using cylindrical lenses ( $\leq 0.50$  D). 53.19% patients had best spectacle corrected visual acuity between 6/6- 6/9 while using cylindrical lenses  $\leq 0.50$ D, in patients conducted SICS only while 12.77% patients had uncorrected visual acuity between 6/6-6/9.

Limbal relaxing incision appear to be fairly an effective, safe and a low cost procedure to correct mild to moderate (1-3D) amounts of corneal astigmatism. Under correction is a common limitation which can be modified by newer nomograms in future and can be adjusted by the surgeon's factor.

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