



## Surgically Induced Astigmatism in Tunnel Construction in Small Incision Cataract Surgery

Author

**Raktima Baksi (Mandal)<sup>1</sup>**

<sup>1</sup>RMO-CT (Tutor), Dept. of Ophthalmology, Rampurhat Government Medical College, Birbhum

Corresponding Author

**Raktima Baksi (Mandal)**

### Abstract

**Background:** Manual Small Incision Cataract surgery is the most commonly performed procedure performed worldwide.

**Material and Methods:** Patients operated between July 2014 to June 2016 were included in the study.

**Result:** Out of 210 patients, 6 were lost to follow up. Eventually our sample size reduced to 204 patients of which Linear group consisted of 100 patients and Frown group consisted of 104 patients.

**Conclusion:** Larger incisions induce more astigmatism than smaller one. Astigmatism induced by Straight and Frown incisions do not differ when length of incision is 7.5 mm or more. With the rule astigmatism was noted among patients aged below 50 years and Against the rule astigmatism was seen in people above 50 years of age.

**Keywords:** Astigmatism.

### Introduction

Age related cataract remains the major cause of blindness throughout the world but the huge backlog exists mostly in the developing world<sup>[1]</sup>. According to WHO, 285 million people are estimated to be visually impaired worldwide: 39 million are blind and 246 million have low vision. India is now home to the world's largest number of blind people. Of the 39 million people across the globe who are blind, over 15 million are from India. In India alone 3.8 million people become blind from cataract every year<sup>[2]</sup> as against 2.7 million cataracts done every year<sup>[3]</sup>. The aim of Cataract surgery is to provide best possible and early visual outcome. Cataract extraction is most cost effective of all surgical interventions<sup>[4]</sup> in type of quality restored<sup>[5]</sup>.

Until recently, MSICS (Manual Small Incision Cataract Surgery) was considered as a low-tech, unproven poor cousin to the gold standard phacoemulsification. The advantages of MSICS as a low cost "equally effective" technique, makes it an alternative, especially in an unequally developed country like India<sup>[6]</sup>. It has allowed wound size to be reduced in size, and to provide a stable, self-sealing surgical wound enabling the cataract patient virtually full activity in the immediate postoperative period.

Ever since astigmatism was reported after surgery, it has intrigued surgeons for over a century and has remained one of the major obstacles to achieving of the goal of rapid and stable visual rehabilitation. Astigmatism is defined as that condition of refraction where a point focus of light cannot form

upon the retina<sup>[7]</sup>, with the accommodation remaining at rest. Astigmatism is due to error of curvature, refractive index, or decentration of Lens<sup>[7]</sup>. By convention, with-the-rule astigmatism (WTRA) has its meridian with the least radius of curvature (steepest) or greatest refracting power in a vertical meridian; against-the-rule astigmatism (ATRA) is the converse, with the curvature of least radius or most refractive power in horizontal meridian. Surgically Induced Astigmatism (SIA) in its immediate post-operative state present as WTRA, but later shifts to ATRA. Thus, the astigmatism that we see after cataract surgery is variable and depends on the incision viz size, site, method of preparation and closure of the surgical wound. Surgically induced astigmatism also depends on operative and post-operative manipulation, sutures (if used) and time elapsed since surgery.

This is an endeavour to study Manual Small Incision Cataract Surgery in relation to complications and visual rehabilitation and also to ascertain the effect of different types of scleral incisions upon post-operative astigmatism. One of the unavoidable inevitabilities of cataract surgery is surgically induced astigmatism (SIA).

### Aims & Objectives

The present study is aimed at performing A scan and keratometry pre-operatively and post-operatively in patients who will be undergoing cataract operation and will be present in operation theatre. Aim is to minimize postoperative astigmatism so as to provide clear, strain free vision.

### The objectives of the study are

- To compare pre-operative corneal astigmatism with post-operative astigmatism in small incision cataract surgery on 1<sup>st</sup> day post-operative, 2<sup>nd</sup> week, 6<sup>th</sup> week and 3<sup>rd</sup> month.
- To compare the postoperative induced corneal astigmatism in small incision cataract surgery using two different types of incision (frown, straight) varying their incisional length (6.5 mm, 7 mm & 7.5 mm)

### Materials & Methods

The study was conducted in the Department of Ophthalmology, M.G.M Medical College and L.S.K Hospital, Kishanganj, Bihar. Patients were screened from Ophthalmology Outpatient Department, selected and then admitted in the eye ward of the hospital for undergoing surgery during the period, 1<sup>st</sup> July 2014 to 30<sup>th</sup> June 2016.

### Criteria of selection were as follows

Immature cataract in one or both eyes with vision less than or equal to 6/24 in the affected eye, mature cataract, age more than 30 years, patients with age related uncomplicated cataract.

Exclusion criteria: Patients with – Glaucoma, uveitis, traumatic cataract, congenital cataract, less than 30 years of age, scleral thinning, keratoconus, disease of cornea, e.g. dystrophy, degeneration, dry eye, any active ocular disease, immune-compromised patient, presence of diabetes mellitus, prior intra-ocular surgery, e.g., filtering bleb, patient those were lost to follow-up, presence of collagen vascular disease, patients showing astigmatism in 70-110 and 160-20 degree axes during refraction were selected. Others were excluded like cases requiring sutures to close the tunnel.

Surgery was done by different surgeons. 204 patients were studied.

- mm of incision was used in – Posterior subcapsular cataract, posterior cortical cataract, early immature cataract, advanced immature cataract
- mm of incision was used in –Hyper-mature cataract, advanced immature cataract.
- mm of incision was used in –Nuclear cataract (Black Cataract), intumescent cataract, mixed cataract, cortical mature cataract.

### Methods

Keratometry was done in order to assess the cylindrical error of the anterior surface of the cornea. It was measured with a Bausch and Lomb Keratometer, range 36-52D.

Keratometric readings were taken preoperatively at the time of admission at outpatient department and

postoperatively in 1<sup>st</sup> week, 2<sup>nd</sup> week, 6<sup>th</sup> week and 12<sup>th</sup> week. (Astigmatically, the wound stabilizes by 6 weeks after surgery<sup>12</sup>. So, 12 weeks were enough as the end point of the study).

### Study Design

The eyes were divided into two major Groups (I and II) according to the type of incision applied.

#### Group- I:

Eyes in this group received a Linear incision. This group consisted of 100 patients and they were divided into two subgroups on the basis of the length of incision:

Subgroup A	Incision size 6.5 mm
Subgroup B	Incision size 7.0 mm
Subgroup C	Incision size 7.5 mm

#### Group – II:

Eyes in this group received a Frown incision. This group consisted of 104 patients and they were divided into two subgroups on the basis of the length of incision:

Subgroup A	Incision size 6.5 mm
Subgroup B	Incision size 7.0 mm
Subgroup C	Incision size 7.5 mm

### Results

The present prospective study was performed to assess the SIA following non phaco MSICS.

All 204 patients, divided into 2 groups (Group I, Group II) and study underwent preoperative and postoperative keratometry at Day1, 2<sup>nd</sup> week, 6<sup>th</sup> week and 12<sup>th</sup> week after surgery. Only the induced astigmatism at the end of 12 postoperative weeks is being mentioned. Induced Astigmatism assessed by Keratometer where,

- $K_1$  or preoperative keratometric astigmatism.
- $K_3$  or postoperative keratometric astigmatism after 12 weeks of surgery.
- $K_2$  or surgically induced astigmatism 12 weeks after surgery which is the difference of  $K_3$  from  $K_1$ .

In the present study, the following points were observed.

### 1. Distribution of axis of preoperative astigmatism in all groups of the patient.

In Group I Control had with-the-rule astigmatism (WTR) 61%, against-the-rule astigmatism were 26% and 13% had zero astigmatism. Similarly, in study sub-group I under Group I WTR were 86%, ATR were 14% and zero astigmatism were in 0% among the patients. In Group II Control had with-the-rule astigmatism (WTR) 66%, ATR astigmatism was 28% and zero astigmatism were 6% In study sub-group II under Group I WTR were 58%, ATR were 34% and zero astigmatism were in 8% of the patient. In study sub-group I of Group II WTR astigmatism had 71%, ATR astigmatism 29% and zero astigmatism 0%. Similarly, in study sub-group II of Group II WTR astigmatism had 69%, ATR astigmatism 31% and zero astigmatism 0%.

### 2. Relationship of age of the patient with astigmatism preoperatively given as below:

- **Patient aged between 40 and 55 years of age** – WTR astigmatism 4.9% of total number of studied patients, ATR astigmatism 4.90% and Zero astigmatism 3.92%.
- **Patient aged between 56 and 65 years of age** – WTR astigmatism 26.47% of total number of studied patients, ATR astigmatism 26.92% and Zero astigmatism 1.96%.
- **Patient aged between 66 and 75 years of age** – WTR astigmatism 29.41% of total number of studied patients, ATR astigmatism 13.46% and Zero astigmatism 0.98%.
- **Patient aged over 75 years of age** – WTR astigmatism had 4.90% total number of studied patients  
ATR astigmatism 2.94 %

This is in accordance with the fact that corneal curvature changes with age. During infancy, it is spherical, in adolescence it is with-the-rule astigmatism. In old age cornea become more spherical and develops against-the-rule astigmatism.

### 3. Distribution of axis of postoperative astigmatism in all group of the patient.

In Group I Control had postoperative WTR astigmatism 37% whereas ATR 50% and zero astigmatism 13%. In study sub-group I of Group I

had WTR astigmatism had 43%, ATR astigmatism 57%. Similarly, in study sub-group II of group I had WTR astigmatism 50%, ATR astigmatism 50%. In Group II Control WTR astigmatism had 50%, ATR astigmatism were 47% and zero astigmatism were 3%. In study sub-group I of group II WTR astigmatism had 57%, ATR astigmatism were 29% and zero astigmatism were 14%. Similarly, in study sub-group II of Group II WTR astigmatism had 46%, ATR astigmatism 54% .

**4. Mean SIA astigmatism.**

In the group I Control (with 6.5 mm straight incision) was 1.18D ± 6.379D whereas in Group I case or study sub-group I (with 7.0 mm straight incision) and study sub-group II (with 7.5 mm straight incision) it was 0.812D ± 2.83D and 0.812D ± 8.938D respectively.

In the same period postoperatively Mean SIA astigmatism in the Group II Control with (6.5 mm Frown incision) was 1.299D ± 1.091D, whereas in Group II study sub-group I (with 7.0 mm Frown incision) and Group II study sub-group II (with 7.5 mm Frown incision) it was 1.157D ± 2.624D and 0.634D ± 2.112D respectively.

**5.** 77.41% of Control Group I had K<sub>1</sub> (preoperative) within 1.00D and about 19.35% were in the range of 1.00-2.00D. In the study sub-group, I and study sub-group II of Group I were 71.42%, 28.57% and 45.0%, 50% respectively. Similarly, 59.37% of Control Group II had K<sub>1</sub> (preoperative) astigmatism within 1.00D and 40.62% were in the range of 1.00-2.00D. In the study sub-group, I and study sub-group II of Group II it was 71.96%, 28.56% and 53.84%, 30.76% respectively.

45.16% of Control in Group I had K<sub>3</sub> (postoperative) within 1.00D and 35.48% were between 1.00D and 2.00D. In the study sub-group I and study group II of Group I it was 57.13%, 42.85%, 49.99%, 24.99% respectively.

In Control Group II K<sub>3</sub> (postoperative keratometry) had within 1.00D in 34.37% and in the range of 1.00D-2.00D it is about 31.25% cases.

Study sub-group I and study sub-group II of Group II the same astigmatism found in 42.85%, 57.13% and 30.76%, 38.45% of cases.

Of the 204 participants in this study, the youngest was 45 years old and the oldest was 90 years old. The mean age in this study was 60.05 years. There was a total of 106 (51.96%) males and 98 (47.34%) females. Linear Group consisted of 54 (54%) males and 46 (46%) females while Frown Group consisted of 52 (50%) males and 52 (50%) females.

**Surgically Induced Astigmatism (K<sub>2</sub>)**

The difference between the measured postoperative astigmatism (K<sub>3</sub>) and measured preoperative astigmatism (K<sub>1</sub>) at any given time gives the surgically induced astigmatism (K<sub>2</sub>).

$$K_2 = K_3 - K_1$$

The surgically induced astigmatism for the Frown Group (Group I at different period of time is given in the table:

**Table: SIA in Frown Group**

Follow Up	6.5 mm Group		7.00 mm Group		7.5 mm Group	
	M.A	S.I.A	M.A	S.I.A	M.A	S.I.A
Pre-op	0.87	-	0.914	-	1.20	-
Day 1	1.62	0.97	1.4	0.88	1.68	0.70
Week 2	1.78	1.15	1.58	1.071	1.65	0.69
Week 6	1.77	1.32	1.82	0.75	1.95	1.03
Month 3	1.59	1.22	0.97	1.15	1.61	0.63

All values in Dioptre

The surgically induced astigmatism for the Linear Group (Group II) at different period is given in the table:

**Table: SIA in Linear Group**

Follow Up	6.5 mm Group		7.00 mm Group		7.5 mm Group	
	M.A	S.I.A	M.A	S.I.A	M.A	S.I.A
Pre-op	0.66	-	0.95	-	0.99	-
Day 1	1.28	0.89	1.27	0.80	1.31	0.85
Week 2	1.44	0.33	1.40	0.72	1.41	1.00
Week 6	1.24	0.98	1.94	1.507	1.51	1.25
Month 3	1.40	1.18	0.94	1.178	1.30	0.81

All values in Dioptre

**Discussion**

The present study is an endeavour to analyse the manual small incision cataract surgery and the amount of surgically induced astigmatism by Linear and Frown types of scleral incision.

### Preoperative Keratometric

#### Astigmatism

In this study the mean preoperative measured keratometric astigmatism of the 204 eyes was 0.69 D, with 0.693 D and 0.689 D in the Linear and Frown group. Jaffe et al., and Clayman et al., (1975) from their series of 1557 eyes of patients 44 to 94 years of age reported an average preoperative astigmatism of 0.64 D<sup>[8]</sup>.

The distribution of the pattern of preoperative astigmatism in our series is given below:

Majority of eyes (134 out of 204 eyes) had WTR astigmatism accounting for 65.68% of the study. ATR astigmatism was seen in 58 out of 204 eyes, accounting for 55.76% of the series. In both the Linear and Frown group all the eyes with WTR astigmatism were belonged to the age group 31-70 years, with the majority being below 50 years whereas all the eyes with ATR astigmatism were above 50 years of age group. The preoperative pattern of astigmatism in this study was similar to most authors, though variation can be seen. The age of the study group is also an important factor.

The magnitude of measured preoperative astigmatism in this study ranged within 1.0 D WTRA to 1.0 D ATRA. In the Linear and Frown group 81.25% and 84.84% of patients respectively had a preoperative astigmatism between 0.51 to 1.0 D. Cavara et al., (1922) found out that 81.56% of patients had preoperative corneal astigmatism less than 1.5 D.

### Postoperative Keratometric

#### Astigmatism

Analysing the results of the present study, it is evident that the amount of measured astigmatism was high on the first postoperative day. Average measured astigmatism on 1<sup>st</sup> day was 0.32D and 0.25D for Linear and Frown Group respectively, and on the 2<sup>nd</sup> week the values were 0.37D and 0.57D respectively. Then it showed gradual decline over to 3<sup>rd</sup> month with values of 0.29D and 0.05D for Linear and Frown Group respectively. Sinks et al., and Stoppel et al., (1994) reported a mean induced keratometric astigmatism of 0.70D, 0.50D

and 0.50D on day1, 1<sup>st</sup> and 3<sup>rd</sup> month in 55 eyes undergoing 6.0 mm no-stitch Frown incision. They concluded that the 6.0 mm no-stitch Frown incision induces low postoperative astigmatism and provides stable refraction. In our study, the mean induced keratometric astigmatism in the Frown Group (6.5 to 7.5 mm) was 0.455D, 0.976D and 0.053D on 1<sup>st</sup> day, 6<sup>th</sup> week and 3<sup>rd</sup> postoperative month.

In this study the measured astigmatism in the Linear (6.5 mm) group on postoperative day 1 and 3<sup>rd</sup> month was 0.32D and 0.29D respectively. The surgically induced astigmatism (SIA) in this study in the Linear Group was 0.278D in the 1<sup>st</sup> postoperative day and on respective follow up on 2<sup>nd</sup>, 6<sup>th</sup> week and 3<sup>rd</sup> month it was 0.377D, 1.138D and 0.293D respectively. In case of the Frown Group it was 0.455D, 0.572D, 0.976D and 0.053D respectively for the above-mentioned period. This shows that SIA in the Frown Group was consistently low at all postoperative periods.

Hayashi et al., K, Yoshida M et al., Hayashi H et al., (2000) reported the mean SIA in their study of 6.5 mm scleral tunnel incisions on 2<sup>nd</sup> day, 1<sup>st</sup> and 3<sup>rd</sup> month as 0.73D, 0.62D and 0.55D respectively<sup>[9]</sup>.

#### Long Term Astigmatic Changes

The pattern of keratometric astigmatism in the present study in the early postoperative period showed majority 92.3% of eyes with WTRA and 3.12% of eyes showing ATRA. The 2<sup>nd</sup> postoperative week showed a change in the trend with an increase in the percentage of ATRA. At the end of the 3<sup>rd</sup> month, 56.9% of eyes had WTRA and 41.5% had ATRA.

In the present study, the surgically induced astigmatism (SIA) by the Linear and Frown incisions were compared and analysed at different postoperative periods. In the 1<sup>st</sup> postoperative day, Frown Group showed lower surgically induced astigmatism than the Linear Group with values of 0.278D and 0.456D respectively. At the 3<sup>rd</sup> month SIA was 0.293D and 0.053D in the Linear and Frown Group. The difference between the mean induced astigmatism on the 1<sup>st</sup> postoperative day between the two groups was statistically significant; however, the difference in induced astigmatism

between the two groups at the end of 3<sup>rd</sup> month was statistically not significant. The finding of this study was similar to that of Singer (1991).

The number of eyes achieving a postoperative uncorrected visual acuity of 6/24 or better in this study was similar between the 2<sup>nd</sup> week (86.14%), 6<sup>th</sup> week (84.61%) and 3<sup>rd</sup> month (90.74%). It is evident that majority of patients achieved good uncorrected vision as early as 2<sup>nd</sup> week and the percentage was comparable till the 3<sup>rd</sup> postoperative month implying early stabilisation and maintenance.

### Conclusion

The conclusions reached in this study are:

Larger incisions induce more astigmatism than smaller one. Straight incisions induce greater astigmatism compared to Frown incisions. Astigmatism induced by Straight and Frown incisions do not differ when length of incision is 7.5 mm or more. Larger incisions are associated with less complication. Different sclera incisions with regard to shape and size have no effect on final visual acuity. Incision within a range of 7mm do not show significant differences in postoperative astigmatism. Postoperative astigmatism stabilises after the second week.

### Reference

1. Thylefors B, Negrel AD, Pararajasegaram R. Global data on blindness. Bull World Health Organization. 1996; 74:319-41.
2. Minasain DC, Mehra V. 3.8 million blinded by cataract each year: Projections of the first epidemiological study of incidence of cataract blindness in India. 1990; 74:341-43.
3. Jose R. National Programme for control of blindness. Indian J Comm. Health. 1997; 3: 5-9.
4. Marseille E. Cost effectiveness of cataract surgery in a public health eye care programme in Nepal. World Health Organisation. Bull OMS. 1996; 74: 319-24.
5. Porter R. Global initiative: The economic case. Community Eye Health. 1998; 27: 44-5.

6. Steinert RF et al. Astigmatism after small Incision Cataract Surgery: A prospective randomized multicentre comparison of 4- and 6.5-mm incision. Ophthalmol 1991; 98: 417-23.
7. Abrams D. Astigmatism. In Duke Elders Practice of Refraction. 9<sup>th</sup> ed. Churchill Livingstone. Edin Lon NY 1978; 52.
8. Jaffe NS, Clayman HM. The pathophysiology of corneal astigmatism after cataract surgery. Trans. Am Acad Ophthalmol Otolaryngol 1975; 79: O P. 615-30.
9. Hayashi K, Yoshida M, Hayashi H. Corneal shape changes after 2.0mm or 3.0mm clear corneal versus scleral tunnel incision cataract surgery. Ophthalmology 2010; 117: 1313-2010.