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A Comparative Study of Surgically Induced Astigmatism in Superior, Supero-Temporal and Temporal Incision in Small Incision Cataract Surgery

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INTRODUCTION

"The eye is the window of the human body through which it feels its way and enjoys the beauty of the world."
The cataract is defined as an opacity in the lens capsule or its substance.

There is an estimated number of people with visual impairment in excess of 161 million; 37 million blind and 124 million suffering from low vision, in the world with 'the leading cause of blindness being cataract'.(1) It is the commonest cause of treatable blindness.Cataract is the main and biggest cause of curable blindness in India and worldwide. The annual incidence of cataract in India has been estimated to be 3.8 million (2) and 1.8 million sight-restoring operations are performed every year.(3)

The field of cataract surgery has been the focal point of exciting mutation during the past two decades and the resurgence of extracapsular cataract surgery as the most effective and least traumatic way of treating cataracts is one major phase in this process. Surgical treatment for cataract has been practiced for centuries and has evolved tremendously.(4) Thousands of years ago in India, Susruta described the first cataract surgery with the depression method of coaching by the anterior root.(5) This paved way for a revolution that would lead to the visual rehabilitation of patients suffering from cataract through a myriad of surgeries.

There have been sporadic and constant efforts through the centuries for novel surgical options to treat cataract. Behind all these endeavors, the sole aim was to restore the patient's vision to the pre-cataract levels with the alleviation of all other symptoms as well.
The cataract surgical rate (CSR) is an important public health metric, which represents the number of cataract operations annually performed per 1 million of the population. There are significant variations in the CSR among different countries.

As expected, the highest rates are seen in countries with the highest gross domestic product. India has dramatically increased its CSR in the last 20 years from less than 1500 to approximately 4000 per million per year currently.
Naturally, the rate of cataract blindness is increasing most rapidly in those countries with lowest CSR. There is clearly a pressing need in the developing world to reduce the backlog of cataract blindness by increasing the CSR over current low rates.

In addition to improving visual acuity (VA), one of the goals of modern cataract surgery is to reduce pre-existing astigmatism (PEA), a factor that may reduce VA and affect the quality of vision.(6)
Today's trend is manual Small Incision Cataract Surgery (SICS) and Phacoemulsification (Phaco) with posterior chamber intraocular lens implantation.
Phacoemulsification is the most favored method in the industrialized countries. In the developing countries like India, manual SICS is the most favored method, as the Phacoemulsification machinery is expensive and it requires maintenance. Also, there is a steep learning curve. (7)

Small incision Cataract Surgery (SICS) - the first choice alternative to phacoemulsification as it retains most of the advantages of "phaco" giving visual results equivalent to phacoemulsification at a lower cost. However, the larger incision used induces greater astigmatism than phacoemulsification. (8)
With improved techniques and increased expectations, surgeons have been paying closer attention to the astigmatic effects of their surgeries. (9)
Minimal postoperative astigmatism, rapid visual rehabilitation and the best corrected visual acuity possible are the aims of modern cataract surgery. The axiom today in the rehabilitation of a patient of cataract is "Small is beautiful". (10)
Small incision cataract surgery (SICS) through a sclerocorneal tunnel has come as a boon as it has been demonstrated that smaller the incision valvular construction of wound would induce minimal astigmatism.(11)

AIMS AND OBJECTIVES

1. To compare between the surgically induced astigmatism (SIA) in small incision cataract surgery (SICS) by superior incision, temporal incision, and supero-temporal incision.
2. To evaluate the change in preoperative and postoperative astigmatism.
3. To study the effect of three different incision sites on postoperative best corrected visual acuity.

MATERIALS AND METHOD

Study setting:
The present study has been carried out in the Department of Ophthalmology at Acharya Vinoba Bhave Rural Hospital attached to Jawaharlal Nehru Medical College, Sawangi (Meghe) Wardha, a constituent college of Datta Meghe Institute of Medical Sciences (Deemed University), Nagpur.

Design and source of study:
Rural hospital-based randomized, prospective, comparative study of cataract patients attending eye OPD and referral from other department OPD and indoor patients.
Study Duration:
2 years (September 2015-September 2017)
Sample size:
300 eyes of 300 patients

INCLUSION CRITERIA

1. Patient having cataract of any grade as diagnosed by slit lamp microscopy and distant direct ophthalmoscopy.
2. Patients without any history of ocular pathology and surgery.
3. Patients must be accessible and willing for follow-up.
4. Age group: 40-80 years.

EXCLUSION CRITERIA

1. Patients with additional visual comorbidity which may influence the visual outcome after surgery, viz. glaucoma, corneal and retinal pathologies.
2. Patient having oblique, bi-oblique or irregular astigmatism.
3. Patient having pre-existing astigmatism of >2 D.
4. Patients with traumatic, subluxated cataracts.
5. Systemic pathologies affecting the visual outcome, viz. hypertensive retinopathy and diabetic retinopathy.

Institutional ethical committee approval was obtained.

PLAN OF STUDY

- 300 eyes of 300 patients were randomized in 3 groups having 100 patients in each group.

Group A - includes 100 eyes of 100 patients who underwent small incision cataract surgery by 6mm scleral Superior tunnel incision with implantation of the 6mm optic size polymethylmethacrylate intra-ocular lens.

- Group B - includes 100 eyes of 100 patients who underwent small incision cataract surgery by 6mm scleral Superior-temporal tunnel incision with implantation of the 6mm optic size polymethylmethacrylate intra-ocular lens.
- Group C - includes 100 eyes of 100 patients who underwent small incision cataract surgery by 6mm scleral temporal tunnel incision with implantation of 6mm optic size polymethylmethacrylate intra-ocular lens.
- The three groups were then compared in terms of surgically induced astigmatism, change in pre-operative and post-operative astigmatism and visual outcome on their 1st post op day, 1st post-operative week, 1st post-operative month and 45th postoperative day.
- Surgically induced astigmatism was calculated using vector analysis method.

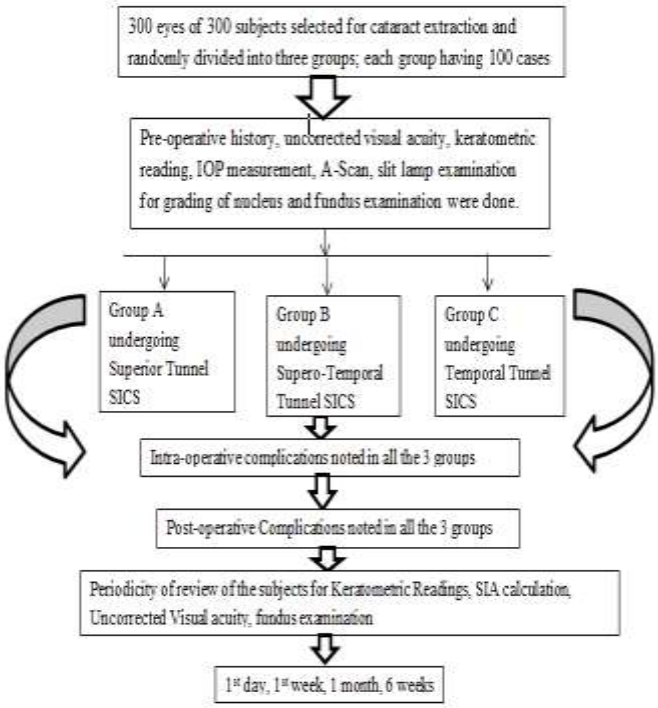

Fig 1: The scheme of the present study is diagrammatically depicted as below

Pre-operative Assessment:

The pre-operative assessment of the each subject was done in terms of ss

A) History

A detailed history was taken. The name, age, sex, occupation, address were noted. Any history of trauma, ocular surgery was elicited.

B) Vision:

The Uncorrected visual acuity (UCVA) to detect defects in vision was recorded. The UCVA values were obtained by Snellen's chart or Landolt C chart in case of illiterate patient-operative Assessment:

The pre-operative assessment of the each subject was done in terms of –

C) Ocular Examination:

Detailed ocular examination of the anterior and posterior segment was done by using Appasamy Associates slit lamp REF: AIA-11 5S and slit lamp biomicroscopy with VOLK double aspheric +90D lens and by Hienes Beta direct and indirect ophthalmoscope, respectively.

- Pre-operative intraocular pressure (IOP) was recorded in all patients by Applanation Tonometer.
- Syringing was performed for each of the patients.
- Pre-operative keratometric reading was taken for all the cases with the help of Bausch and Lomb Keratometer (keratometer Super KMS 6).
- The axial length and IOL power calculation were done in all the subjects with the help of A-Scan biometry using the SRK-II formula.
- On slit-lamp examination, cataract was graded using LOCS classification.
- The amount and type of astigmatism were noted in all patients.
- Type of astigmatism was

  WTR- 90±20 degrees; between 60 degrees and 120 degrees

  ATR- 0-20 degrees; 150-180 degrees

Other investigations:

Routine investigations like measuring temperature, pulse, respiratory rate & blood pressure and estimating blood sugar, ECG were done in all subjects.

Consent:

A written informed consent was obtained in each case pre-operatively.

Pre-operative preparation:

All the patients were given antibiotic eye drops pre-operatively (Moxifloxacin 0.5%). Xylocaine sensitivity test was done in each case pre-operatively in the ward. Injection Tetanus Toxoid 0.5 mg was given intra-muscularly in each case.
The Operating eye was dilated with Topical tropicamide 0.8% with phenylephrine 5% and also flurbiprofen (non-steroidal anti-inflammatory) eye drops was installed every 15 minutes, 1 hour before the surgery for maintenance of dilatation.
Anaesthesia:

A peribulbar anaesthesia of five ml injection of xylocaine 2% with 1:200000 adrenaline with one ampule (150 USP units) of hyaluronidase at the junction of lateral 1/3 and medial 2/3 of orbital wall at inferior orbital margin & three ml injection at the junction of lateral 2/3 and medial 1/3 of orbital wall at superior orbital margin was given. Following the injection, digital ocular massage was carried out for at least 3-5 minutes in all of the cases.
Material used:

- Wire speculum
- Superior Rectus Forceps
- Superior Rectus Thread and needle
- Section Enlarging Forceps
- St. Martin Forceps
- Haberle-McPherson lens holding forceps
- Suture Tying Forceps
- Ophthalmic keratomes*:*

 Lance tip
 Crescent
 Keratome (3.2mm)
 Keratome (5.2mm)

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- Suture Tying Forceps
- Ophthalmic keratomes:

 Lance tip
 Crescent
 Keratome (3.2mm)
 Keratome (5.2mm)

2cc and 5cc syringes

- Viscoelastic solution (Hydroxy Propyl Methyl Cellulose 2%)
- Visco cannula
- 26 Gauge needle
- Trypan blue dye
- Simcoe’s irrigation and aspiration cannula
- Hydro dissection cannula
- Sinskey Hook (Dialer)
- Intraocular lens: rigid polymethylmethacrylate IOL with 6mm optic Size.

Surgical Procedure:

Patients were randomly selected for 3 different Incision techniques.

All surgeries were performed by the single surgeon.

The ocular adnexa were cleaned with 5% povidone iodine solution and the surgical field with the sterile drape. Wire speculum was applied and conjunctival wash was given.

Intervention:

- SUPERIOR SCLERAL INCISION:
- Superior rectus suture was fixed. For Temporal scleral tunnel lateral rectus was fixed.
- Fornix based conjunctival flap between 10 to 2 O'clock position was dissected for Superior tunnel incision.
- Hemostasis was achieved wet field-bipolar cautery
- Single side port at 10 o' clock was made with a 15 degree Lance tip knife
- Anterior capsule was stained with trypan blue dye
- Anterior chamber (AC) wash given
- AC filled with visco-elastic material
- A 6mm Continuous Curvilinear Capsulorrhexis (CCC) performed in a closed chamber with bent 26 gauge needle (cystitome) through the side port35

A partial thickness 6mm scleral frown incision was made with 11 no. bard parker blade 2mm from the limbus

- A sclera-corneal tunnel is fashioned using a bevel up crescent blade and extended up to1mm into clear cornea.11
- The pocket tunnel dissection is carried forward 1mm into the clear cornea in front of the vascular arcade.
- A 3.2 mm angled keratome was used to enter the AC to form a three-stepped self-sealing tunnel incision.
- The incision was enlarged with a 5.2 mm angled keratome, such that the internal corneal lip was kept about 25% larger than the external incision to facilitate the smooth delivery of the nucleus
- Hydrodissection and hydrodilneation was performed by injecting ringer lactate through a 27 gauge cannula separating the cortex and epinucleus of the lens from the har

dcore nucleus, till it can be rotated freely clockwise or counter-clockwise in the bag

- A visco cannula was used to facilitate nuclear prolapse from the bag into the AC through CCC19
- The AC was filled with visco-elastic substance both above and below the nucleus to protect the bag posteriorly and endothelium anteriorly during the delivery of nucleus.
- The nucleus was delivered out of the AC through the tunnel by hydro procedure created by corrugated wire vectis
- Most of the cortex was expressed out through visco-expression by injecting visco-elastic material while pressing the inferior lip of the tunnel
- The residual cortex was aspirated using a Simcoe's 2-way irrigation and aspiration cannula manually
- A 6 mm optic size (overall 12.5mm) single piece posterior chamber PMMA-IOL was then implanted into the capsular bag with the help of McPherson's forceps and dialer
- The remaining visco-elastic material was aspirated, AC reformed with ringer lactate and side port was hydrated
- The integrity of the self-sealing sclera incision was ensured and the cut conjunctival flap was opposed using a forcep fitted to bipolar cautery.

All patients received 2mg of dexamethasone and 20mg of gentamicin subconjunctivally. The eye was patched by eye pads.

There is no more difference in surgical steps of temporal or supero-temporal as compared to superior small incision cataract surgery. Before considering surgery through a temporal or supero-temporal incision, certain modification of the surgical set up and adjustments are necessary.

- TEMPORAL SCLERAL INCISION:
- The surgeon is required to perform the surgery from the side and hence instead of sitting towards the head of the patient, sits by his corresponding side.
- Operating Microscope needs to be positioned accordingly.
- As there is no support for the surgeon's wrist, some kind of support (eg.in the form of 2 cushions) has to be used.
- Bridle suture is passed underneath the lateral rectus muscle instead of the superior rectus muscle.
- The incision is taken from 10 o'clock to 8 o'clock in the Right eye and 4 o'clock to 8 o'clock in the left eye.
- The side Port is made around 1 to 2 clock hours away from the main port at 6 o'clock position for right eyes and Superior 12 o'clock hour for the left eyes.
- All the steps of the surgery in temporal scleral tunnel are the same as those being performed from 12'o clock position but the incision has to be beveled more anteriorly as

the temporal limbus is away as compared to the superior limbus.

- SUPERO-TEMPORAL SCLERAL INCISION:

- The surgeon is required to sit laterally towards patient's shoulder and perform surgery.
- For right eye, incision is need to be placed at 12 to 10 o'clock and for left eye at 2 to 12 o' clock hour position.
- Rest of the steps used in this procedure was similar to the superior incision group.

POST-OPERATIVE TREATMENT:

All patients were given

Systemically:

- Tab. Ciprofloxacin 500mg BD for 3 days
- Tab. Ibuprofen 200mg BD for 3 days
- Tab. Ranitidine 150mg BD for 3 days

Locally:

- Combination of Dexamethasone (0.1%) + Moxifloxacin (0.5%) eye drop initially 2 hourly for one week decreasing to four times for 6 weeks.
- Homatropine 2% eye drops BD for 1 week

Post-operative follow-up:

All the subjects were followed for a period of one and half months. Each subject was followed up post-operatively on days 1st, 7th, 1 month and 6 weeks.

At each of the follow-up, patient was examined for

- Uncorrected Visual acuity by Snellen's chart or Landolt C chart in the illiterate patient.
- Slit lamp examination and slit lam biomicroscopy
- Keratometry using Bausch and lomb keratometer (Super KMS 6)
- Post-operative keratometric evaluation:

The post-operative keratometry was done at each follow-up on day 1st, 7th, 1 month and 6 weeks.

The course of postoperative corneal astigmatism changes was determined by keratometry.

For simplification of analysis, all astigmatic changes were studied only in the vertical and horizontal meridian. Oblique astigmatism was not studied.

The amplitude of preoperative and postoperative astigmatism was calculated from the difference in the keratometric value in the steeper and flatter meridian, using the plus cylinder notation. Astigmatism was considered a vector with a magnitude equal to this value, directed towards the steeper meridian. For example, keratometry values of 43.5 x 900 and 44 x 1800 would imply astigmatism of 0.5 D 180 degree.

The Surgically Induced Astigmatism was calculated by Vector Analysis Method at each follow-up.

Astigmatism vectors are drawn using a protractor and a ruler;

A horizontal baseline is drawn, on which a center point is marked.

First, the pre-operative vector (say K1) is depicted by drawing a line from the center outward, at an angle double the pre-operative astigmatism angle, and equal in length to the magnitude of pre-operative astigmatism.

For the magnitude, a convenient scale can be chosen (in the present study, the scale used was 1 dioptre= 1 centimeter).

Then, the post-operative vector (say K2) is drawn, again beginning at the center and going outwards. These two lines are joined. This third line is the resultant vector and represents SIA (say K3). The junction of this line and the post-operative vector is marked as the 'head', and its other end as a tail.

To determine the exact SIA, this Line is measured and the reading is converted into dioptric value using the earlier scale. This is the magnitude of SIA.

The horizontal line is drawn through the tail of the resultant vector, and the angle that the resultant makes with it is measured. Half of this angle is the axis of SIA.

The statistical analysis of the main outcome variables was done by application of appropriate statistical methods.

Glasses were prescribed after 6 weeks by using an Auto refractometer and subjective verification.

STATISTICAL ANALYSIS

All data were analyzed with the assistance of biostatistician, Dept. of community medicine, Jawaharlal Nehru Medical College, Sawangi, Wardha.

Statistical analysis was done by using descriptive and inferential statistics using Chi-square test, One-way ANOVA and Multiple comparison Tukey Test. The analysis was done by using SPSS software (Statistical Package for the Social Sciences, version 17.0) and GraphPad Prism 5.0 version software.

Statistical significance was considered when the p-value was <0.05.

All numerical patient data were entered into a Microsoft Excel spreads*heet.*

OBSERVATIONS AND RESULTS

TABLE 1: AGE WISE DISTRIBUTION OF PATIENTS IN 3 GROUPS

AGE(YEARS)	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of patients	%	Number of patients	%	Number of patients	%	No	%
40-50	6	6	5	5	5	5	16	5.33
51-60	22	22	20	20	31	31	73	24.33
61-70	56	56	60	60	52	52	168	56
71-80	16	16	15	15	12	12	43	14.33
TOTAL	100	100	100	100	100	100	300	100
MEAN± SD	64.60±7.62		65.46±7.26		64.19±7.29		64.75±7.39	
Range	40-80		45-85		50-90		40-90	
⨪2-value	4.12,p-value=0.66,NS,p>0.05							

In the present study, the majority of the patients who underwent SICS were in age group of 61-70 years (56%). The mean age group of the patient in superior scleral incision was 64.60±7.62 years, in Supero-temporal scleral incision was 65.46±7.26 and in temporal scleral incision, it was 64.75±7.39 years. Hence by using chi-square test, p value=0.66, there was no statistically significant difference between the age of patients in three groups (p >0.05).

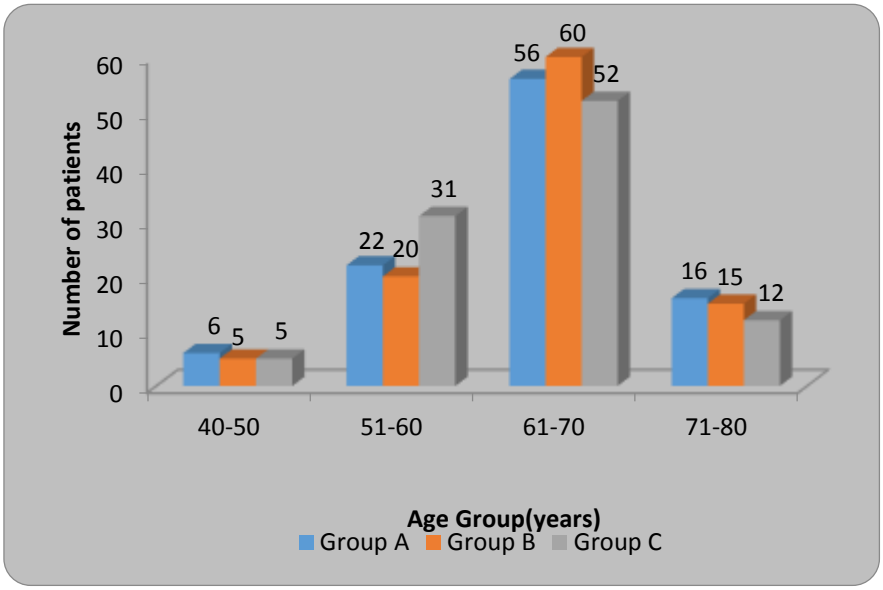
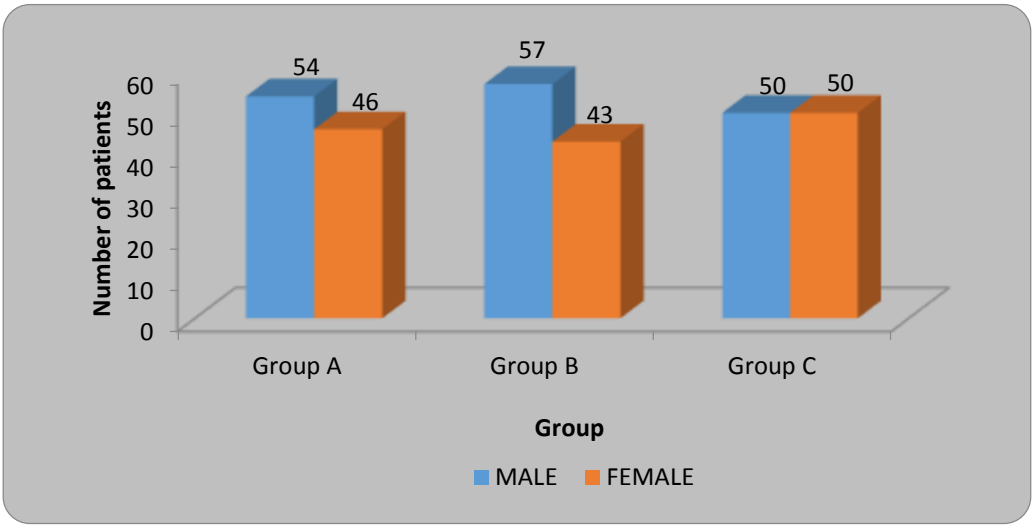


TABLE 2: GENDER WISE DISTRIBUTION OF PATIENTS IN 3 GROUPS

GENDER	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of patients	%	Number of patients	%	Number of patients	%	Number of patients	%
MALE	54	54	57	57	50	50	161	53.67

FEMALE	46	46	43	43	50	50	139	46.33
TOTAL	100	100	100	100	100	100	200	100
ϰ2-value	0.99,p-value=0.60,NS,p>0.05							

In the present study, in superior scleral incision group 54 (54%) patients were male and 46 (46%) patients were female, in Supero-temporal scleral incision group 57 (57%) patients were male and 43 (43%) patients were female and in temporal scleral incision group 50 (50 %) patients were male and 50 (50%) patients were females. Overall 161 (53.67 %) patients were male and 139 (46.33 %) patients were females in all the three groups. By using chi-square test, p value=0.60, there was no statistically significant difference found among gender distribution in three groups (p >0.05).

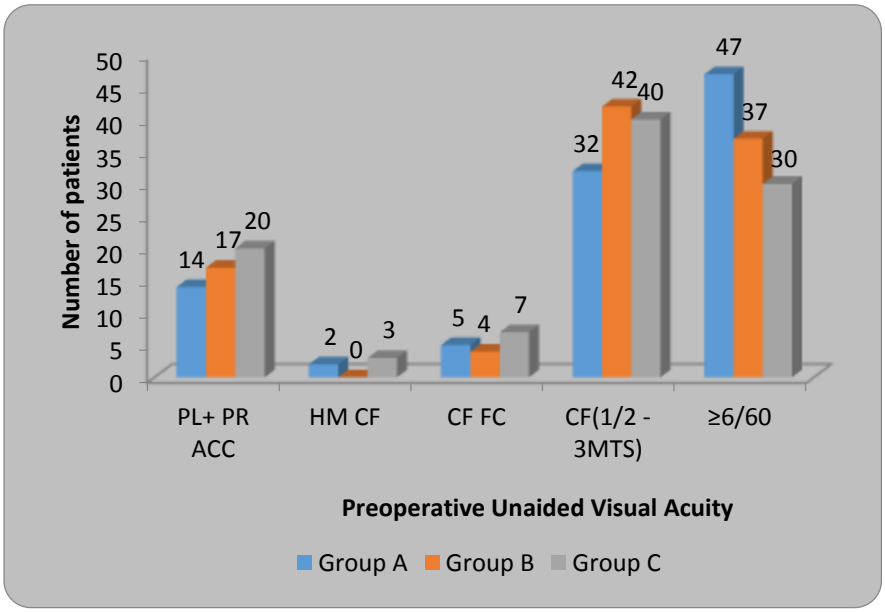


GRAPH 2

TABLE 3: DISTRIBUTION OF PRE-OPERATIVE UNAIDED VISUAL ACUITY IN 3 GROUPS

PRE-OPERATIVE UNAIDED VISUAL ACUITY	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of patients	%	Number of patients	%	Number of patients	%	Number of patients	%
PL+ PR ACC	14	14	17	17	20	20	51	17
HM CF	2	2	0	0	3	3	5	1.67
CF FC	5	5	4	4	7	7	16	5.33
CF(1/2 - 3MTS)	32	32	42	42	40	40	114	38
≥6/60	47	47	37	37	30	30	114	38
TOTAL	100	100	100	100	100	100	300	100
ϰ2-value	10.05,p-value=0.26,NS,p>0.05							

In the present study, the pre-operative visual acuity was <6/60 in 62% patients in all the three groups whereas 38% patients had pre-operative visual acuity of more than or equal to 6/60. By using chi-square test, p value=0.26, there was no significant difference between the three groups.



GRAPH 3

In the present study, maximum eyes in all the three groups i.e. 58 (58%) eyes in Superior scleral incision, 59 (59%) eyes in Supero-temporal scleral incision and 61 (61%) eyes in Temporal

TABLE 4: DISTRIBUTION OF PRE-OPERATIVE TYPE OF ASTIGMATISM IN 3 GROUPS

PRE-OPERATIVE TYPE OF ASTIGMATISM	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
ATR	58	58	59	59	61	61	178	59.33
WTR	28	28	28	28	28	28	84	28
NA	14	14	13	13	11	11	38	12.67
TOTAL	100	100	100	100	100	100	300	100
ϰ2-value	0.44,p-value=0.97,NS,p>0.05							

the scleral incision had against- the rule astigmatism pre-operatively.
28 (28%) eyes in the superior scleral incision, 28 (28%) eyes in supero-temporal incision and 28 (28%) eyes in temporal scleral incision had with -the rule astigmatism.
14 (14%) eyes in superior scleral incision, 13 (13%) eyes in supero-temporal incision and 11 (11%) eyes in temporal scleral incision had No astigmatism.
The maximum number of eyes had against –the rule astigmatism in this study pre-operatively i.e. 59.33%.
By using chi-square test, p-value being 0.97 showing that the difference in the three groups was not statistically significant (p>0.05).

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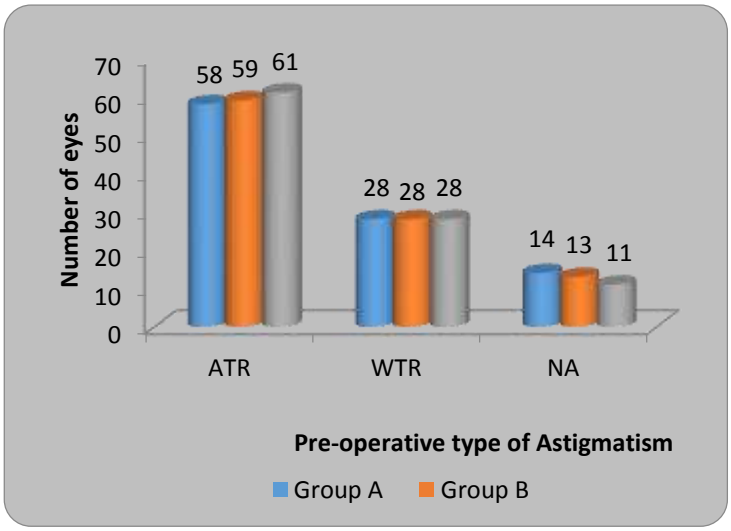
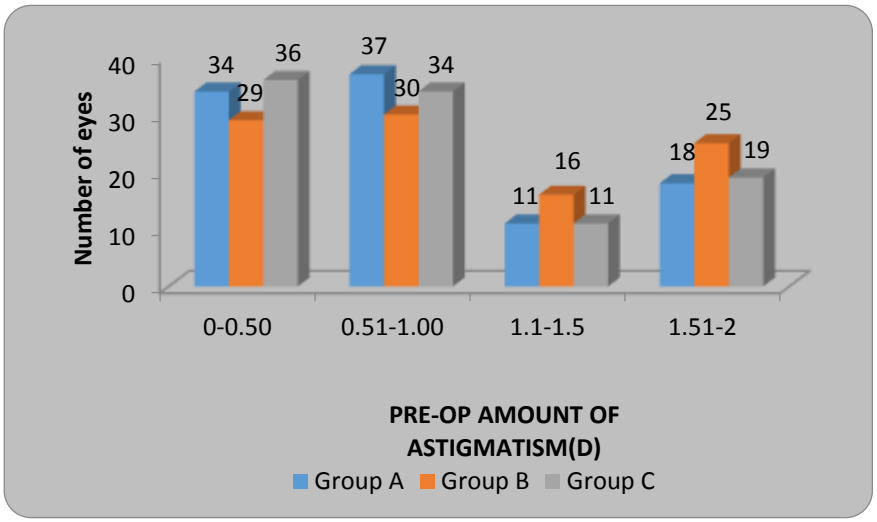


GRAPH 4

TABLE 5: DISTRIBUTION OF PRE-OPERATIVE CORNEAL ASTIGMATISM IN 3 GROUPS

PRE-OP AMOUNT OF ASTIGMATISM(D)	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
0-0.50	34	34	29	29	36	36	99	33
0.51-1.00	37	37	30	30	34	34	101	33.67
1.1-1.50	11	11	16	16	11	11	38	12.67
1.51-2.00	18	18	25	25	19	19	62	20.67
TOTAL	100	100	100	100	100	100	300	100
MEAN±SD	0.88±0.62		1.03±0.66		0.93±0.62		0.95±0.63	
א2-value	4.22,p-value=0.64,NS,p>0.05							

The mean amount of astigmatism pre-operatively in superior scleral incision group was 0.88±0.62, supero-temporal sclrral incision group was 1.03±0.66 and in the temporal scleral group was 0.93±0.62.
By using chi-square test, א2-value is 4.22, the p value= 0.64, there was no statistically significant difference found in the pre-operative corneal astigmatism in the three groups (p>0.05).

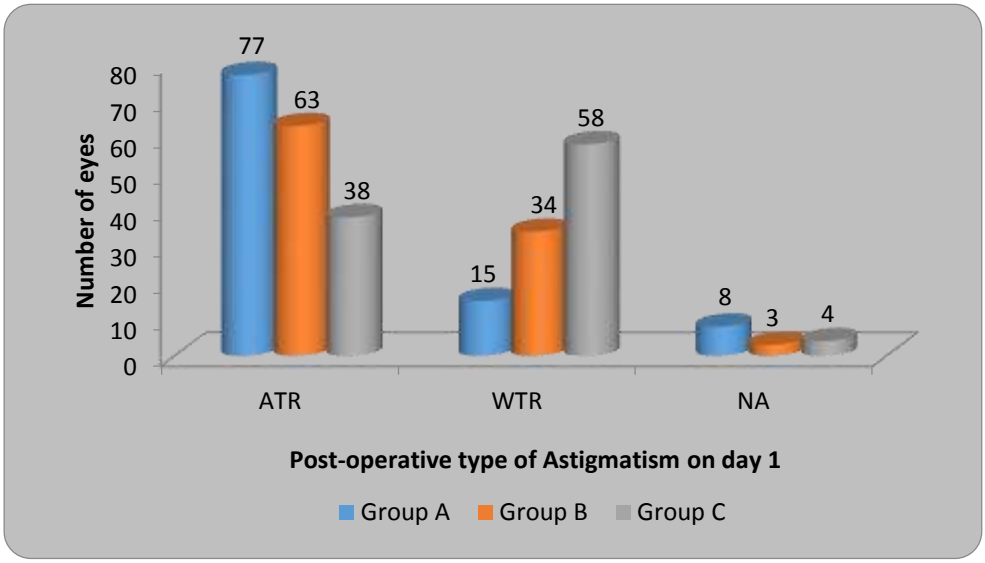


GRAPH 5

TABLE 6: POST-OPERATIVE TYPE OF ASTIGMATISM IN 3 GROUPS ON DAY 1

POST-OP TYPE OF ASTIGMATISM ON DAY 1	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
ATR	77	77	63	63	38	38	178	59.33
WTR	15	15	34	34	58	58	107	35.67
NA	8	8	3	3	4	4	15	5
TOTAL	100	100	100	100	100	100	300	100
ϰ2-value	41.99,p=0.0001,S,p<0.05							

By using chi-square test, ϰ2-value is 41.99, p-value being 0.0001 showing the difference between the groups was statistically significant

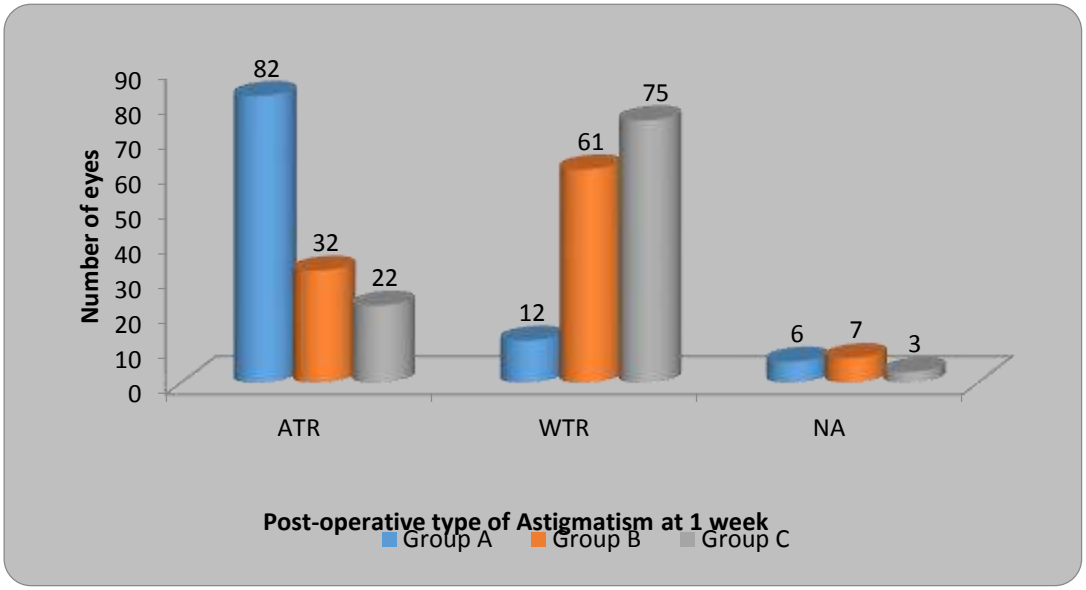


GRAPH 6

TABLE 7: POST-OPERATIVE TYPE OF ASTIGMATISM AT 1 WEEK IN 3 GROUPS

POST-OP TYPE OF ASTIGMATISM AT 1 WEEK	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
ATR	82	82	32	32	22	22	136	45.33
WTR	12	12	61	61	75	75	148	49.33
NA	6	6	7	7	3	3	16	5.33
TOTAL	100	100	100	100	100	100	300	100
א2-value	91.58,p=0.0001,S,p<0.05							

By using chi-square test, א2-value is 91.58, p-value being 0.0001 showing the difference between the groups was statistically significant.

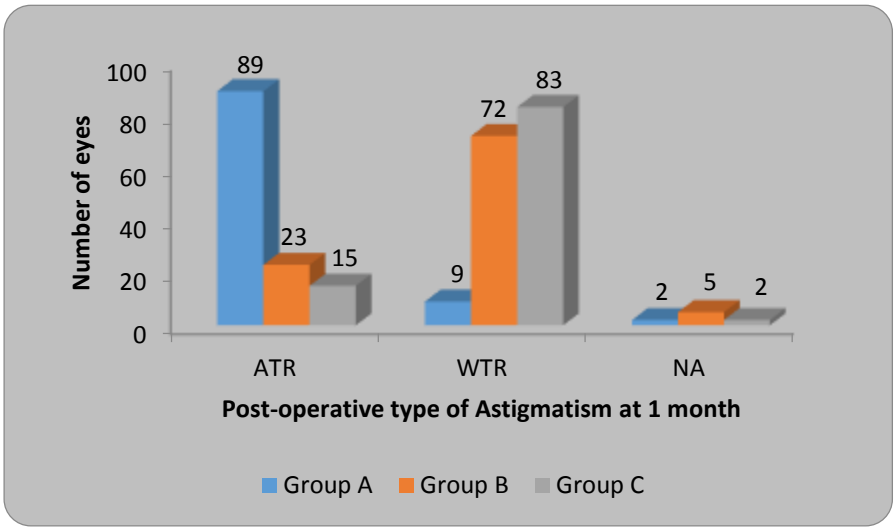


GRAPH 7

TABLE 8: POST-OPERATIVE TYPE OF ASTIGMATISM IN 3 GROUPS AT 1 MONTH

POST-OP TYPE OF ASTIGMATISM ON 1 MONTH	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
ATR	89	89	23	23	15	15	127	42.33
WTR	9	9	72	72	83	83	164	54.67
NA	2	2	5	5	2	2	9	3.00
TOTAL	100	100	100	100	100	100	300	100
ϰ2-value	138.30,p=0.0001,S,p<0.05							

By using chi-square test, ϰ2-value is 138.3, p value= 0.0001 and the difference between the 3 groups was found to be highly statistically significant.

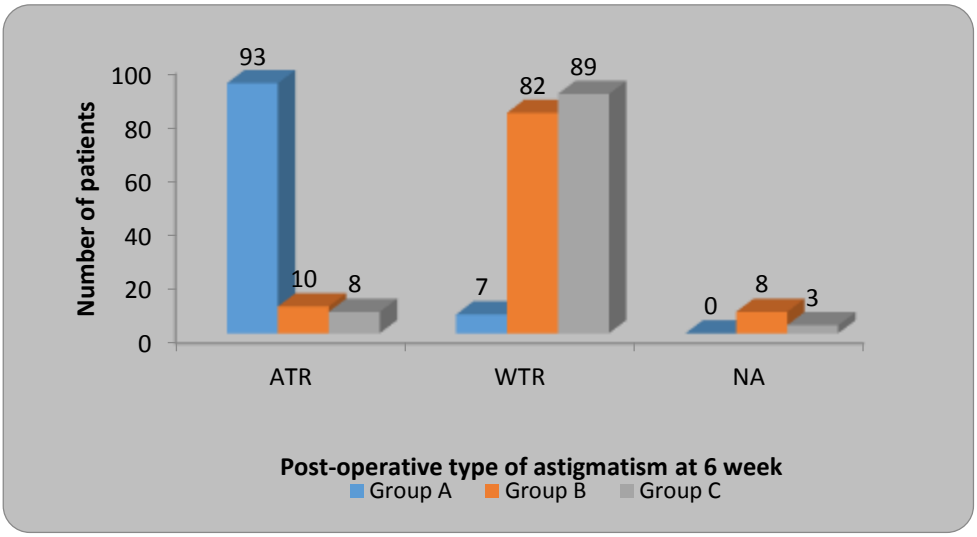


GRAPH 8

TABLE 9: POST-OPERATIVE TYPE OF ASTIGMATISM AT 6 WEEKS IN 3 GROUPS

POST-OP TYPE OF ASTIGMATISM AT 6 WEEKS	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
ATR	93	93	10	10	8	8	111	37
WTR	7	7	82	82	89	89	178	59.33
NA	0	0	8	8	3	3	11	3.67
TOTAL	100	100	100	100	100	100	300	100
ϰ2-value	205.70,p-value=0.0001,S,p<0.05							

by using chi-square test, ϰ2-value is 205.70, p value= 0.0001 and the difference between the 3 groups were found to be statistically significant



GRAPH 9

TABLE 10: COMPARISON OF CHANGE IN TYPE OF ASTIGMATISM IN THREE GROUPS

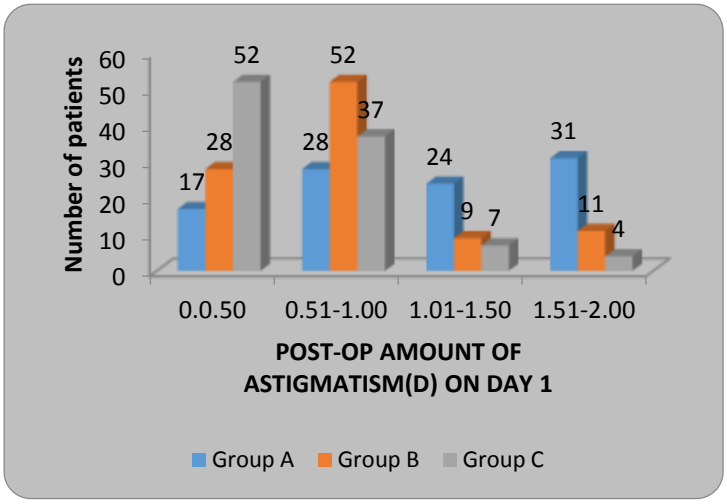
	TOTAL NUMBER OF EYES (%)					
ASTIGMATISM(TYPE)	PRE-OP	POST-OP 1ST DAY	POST-OP 7TH DAY	POST-OP 1 MONTH	POST-OP 6 WEEKS	
GROUP A (SUPERIOR INCISION)						
ATR	58	77	82	89	93	
WTR	28	15	12	9	7	
NA	14	8	6	2	0	
א2-value	48.71,p-value=0.0001,S,p<0.05					
GROUP B (SUPERO-TEMPORAL INCISION)						
ATR	59	63	32	23	10	
WTR	28	34	61	72	82	
NA	13	3	7	5	8	
א2-value	104.4,p-value=0.0001,S,p<0.05					
GROUP C (TEMPORAL INCISION)						
ATR	61	38	22	15	8	
WTR	28	58	75	83	89	
NA	11	4	3	2	3	
א2-value	109.9,p-value=0.0001,S,p<0.05					

In superior incision group, on using chi-square test, א2-value is 48.71, p value= 0.0001, which was statistically significant. In supero-temporal incision group, on using chi-square test, א2-value is 104.4, p value= 0.0001, which was statistically significant. In temporal incision group, on using chi-square test, א2-value is 109.9, p value= 0.0001, which was statistically significant.

TABLE 11.1: POST-OPERATIVE AMOUNT OF CORNEAL ASTIGMATISM IN 3 GROUPS ON DAY 1

POST-OP AMOUNT OF ASTIGMATISM(D) ON DAY 1	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL (n=300)	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
0-0.50	17	17	28	28	52	52	97	32.33
0.51-1.00	28	28	52	52	37	37	117	39
1.01-1.50	24	24	9	9	7	7	40	13.33
1.51-2.00	31	31	11	11	4	4	46	15.33
TOTAL	100	100	100	100	100	100	300	100
MEAN±SD	1.23±0.64		0.87±0.49		0.67±0.43		0.87±0.54	
א2-value	65.91,p-value=0.0001,S,p<0.05							

Mean postoperative amount of astigmatism in superior scleral incision group was 1.23±0.64, in superotemporal scleral incision group was 0.87±0.49 and in temporal scleral incision group, it was 0.67±0.43. By using chi-square test, ϰ2-value is 65.91, p value=0.0001 shows that the difference in the 3 groups was statistically significant

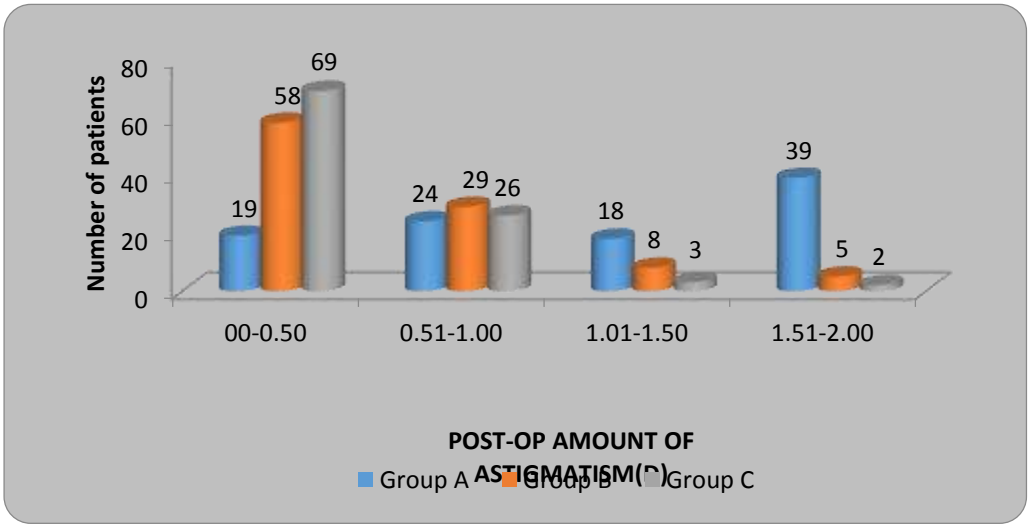


GRAPH 10.1

TABLE 11.2: POST-OPERATIVE AMOUNT OF CORNEAL ASTIGMATISM AT 1 WEEK IN 3 GROUPS

POS-OP AMOUNT OF ASTIGMATISM(D) AT 1 WEEK	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL (n=300)	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
0.0-0.50	19	19	58	58	69	69	149	49.67
0.51-1.00	24	24	29	29	26	26	75	25
1.01-1.50	18	18	8	8	3	3	25	8.33
1.51-2.00	39	39	5	5	2	2	51	17
TOTAL	100	100	100	100	100	100	300	100
MEAN±SD	1.30±0.66		0.66±0.49		0.53±0.32		0.83±0.61	
ϰ2-value	96.01,p-value=0.0001,S,p<0.05							

Mean post-operative amount of astigmatism in superior scleral incision group was 1.30±0.66
, in superotemporal scleral incision group was 0.66±0.49 and in temporal scleral incision group, it was 0.53±0.32. By using chi-square test, ϰ2-value is 96.01, p value=0.0001 shows that the difference in the 3 groups was statistically significant

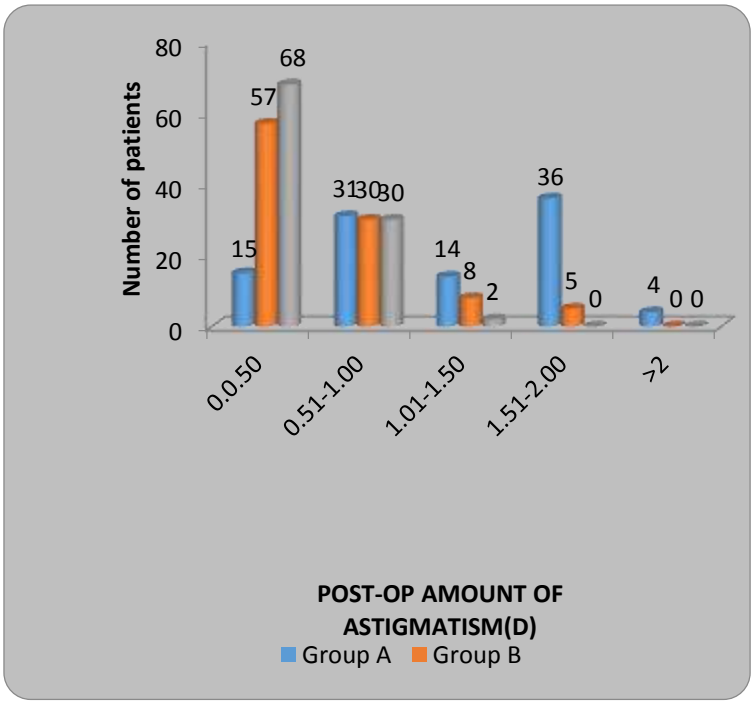


GRAPH 10.2

TABLE 11.3: POST-OPERATIVE AMOUNT OF CORNEAL ASTIGMATISM AT 1 MONTH IN 3 GROUPS

OST-OP AMOUNT OF ASTIGMATISM(D) AT 1 MONTH	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL (n=300)	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
0.0.50	15	15	57	57	68	68	137	45.67
0.51-1.00	31	31	30	30	30	30	94	31.33
1.01-1.50	14	14	8	8	2	2	24	8
1.51-2.00	36	36	5	5	0	0	41	13.67
>2	4	4	0	0	0	0	4	1.33
TOTAL	100	100	100	100	100	100	300	100
MEAN±SD	1.34±0.64		0.67±0.46		0.52±0.26		0.84±0.59	
א2-value	106.2,p-value=0.0001,S,p<0.05							

Mean postoperative amount of astigmatism in superior scleral incision group was 1.34±0.64, in superotemporal scleral incision group was 0.67±0.46 and in temporal scleral incision group, it was 0.52±0.26. By using chi-square test, א2-value is 106.2, p value=0.0001 shows that the difference in the 3 groups was statistically significant

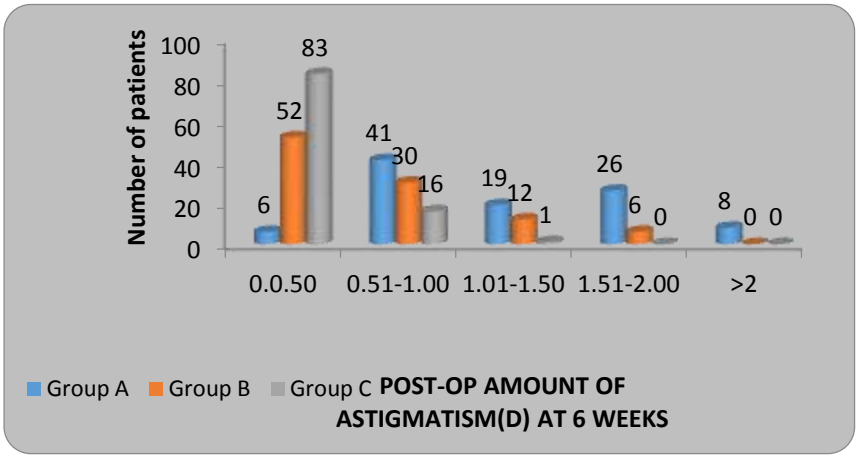


GRAPH 10.3

TABLE 11.4: POST-OPERATIVE AMOUNT OF CORNEAL ASTIGMATISM AT 6 WEEKS IN 3

POST-OP AMOUNT OF ASTIGMATISM(D) AT 6 WEEKS	GROUP A (SUPERIOR INCISION) (n=100)		GROUP B (SUPERO-TEMPORAL INCISION) (n=100)		GROUP C (TEMPORAL INCISION) (n=100)		TOTAL (n=300)	
	Number of eyes	%	Number of eyes	%	Number of eyes	%	Number of eyes	%
0.0.50	6	6	52	52	83	83	141	47
0.51-1.00	41	41	30	30	16	16	87	29
1.01-1.50	19	19	12	12	1	1	32	10.66
1.51-2.00	26	26	6	6	0	0	32	10.66
>2	8	8	0	0	0	0	8	2.67
TOTAL	100	100	100	100	100	100	300	100
MEAN±SD	1.33±0.60		0.69±0.49		0.45±0.24		0.82±0.59	
ϰ2-value	140.98,p-value=0.0001,S,p<0.05							

Mean post-operative amount of astigmatism in superior scleral incision group was 1.33±0.60, in superotemporal scleral incision group 0.69±0.49 and in temporal scleral incision group it was 0.45±0.24.
By using chi-square test, ϰ2-value is 140.98, p value=0.0001 shows that the difference in the 3 groups was statistically significant



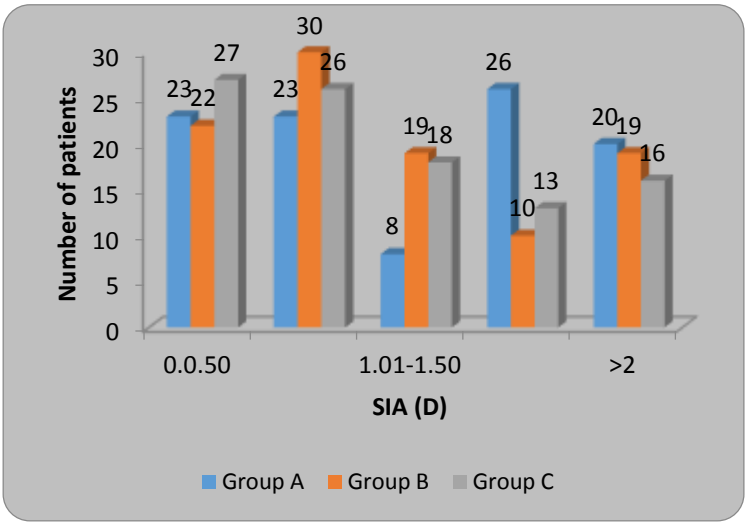
GRAPH 10.4

TABLE 12.1: SURGICALLY INDUCED ASTIGMATISM ON DAY 1 IN 3 GROUPS

SIA (D) ON DAY 1	GROUP A (SUPERIOR INCISION) (n=100)	GROUP B (SUPERO TEMPORAL INCISION) (n=100)	GROUP C (TEMPORAL INCISION) (n=100)	ϰ2-value	p-value
0.0-0.50	23	22	27	15.78	0.04,S, p<0.05
0.51-1.00	23	30	26		
1.01-1.50	8	19	18		
1.51-2.00	26	10	13		

>2	20	19	16		
Total	100	100	100		
Mean ±SD	1.43±0.93	1.25±0.86	1.17±0.74		

The Mean surgically induced astigmatism in superior scleral incision group was 1.43±0.93, in superotemporal scleral incision group was 1.25±0.86 and in temporal scleral incision group, it was 1.17±0.74.
By using chi-square test, ϰ2-value is 15.78, p value=0.04 shows that the difference in the 3 groups was statistically significant.

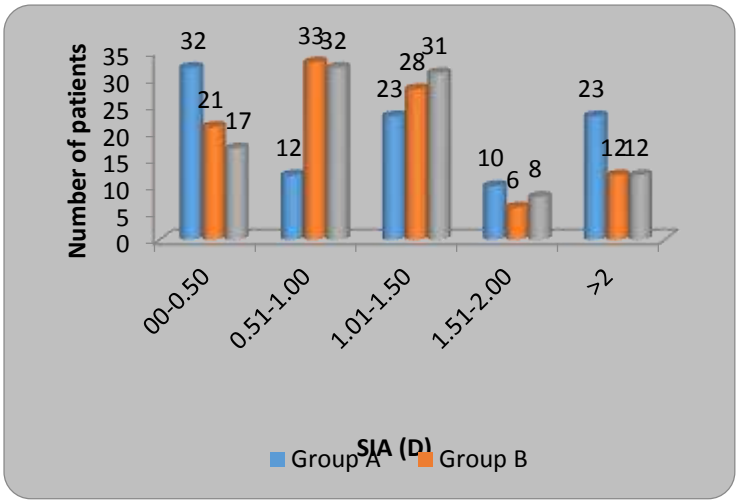


GRAPH 11.1

TABLE 12.2: SURGICALLY INDUCED ASTIGMATISM AT 1 WEEK IN 3 GROUPS

SIA (D) AT 1WEEK	GROUP A (SUPERIOR INCISION) (n=100)	GROUP B (SUPERO TEMPORAL INCISION) (n=100)	GROUP C (TEMPORAL INCISION) (n=100)	ϰ2-value	p-value
00-0.50	32	21	17	23.45	0.0028,S
0.51-1.00	12	33	32		
1.01-1.50	23	28	31		
1.51-2.00	10	6	8		
>2	23	12	12		
Total	100	100	100		
Mean ±SD	1.32±1.00	1.21±0.72	1.19±0.65		

the Mean surgically induced astigmatism in superior scleral incision group was 1.32±1.00, in superotemporal scleral incision group was 1.21±0.72 and in temporal scleral incision group, it was 1.19±0.65.
By using chi-square test, ϰ2-value is 23.45, p value=0.0028 shows that the difference in the 3 groups was statistically significant

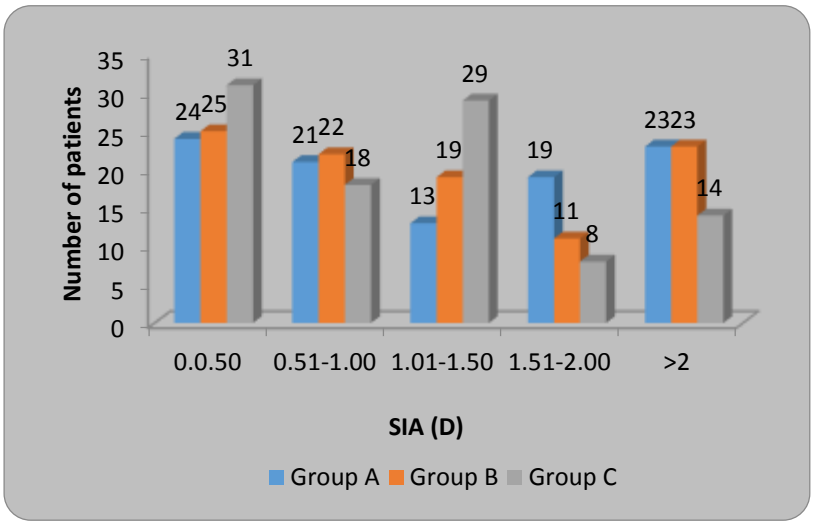


GRAPH 11.2

TABLE 12.3: SURGICALLY INDUCED ASTIGMATISM AT 1 MONTH IN 3 GROUPS

SIA (D) AT 1 MONTH	GROUP A (SUPERIOR INCISION) (n=100)	GROUP B (SUPERO TEMPORAL INCISION) (n=100)	GROUP C (TEMPORAL INCISION) (n=100)	ϰ2-value	p-value
0.0.50	24	25	31	15.73	0.046,S
0.51-1.00	21	22	18		
1.01-1.50	13	19	29		
1.51-2.00	19	11	8		
>2	23	23	14		
Total	100	100	100		
Mean ±SD	1.37±0.94	1.28±0.83	1.15±0.68		

The Mean surgically induced astigmatism in superior scleral incision group was 1.34±0.95, in superotemporal scleral incision group was 1.28±0.83 and in temporal scleral incision group, it was 1.15±0.68.
By using chi-square test, ϰ2-value is 15.73, p value=0.046 shows that the difference in the 3 groups was statistically significant



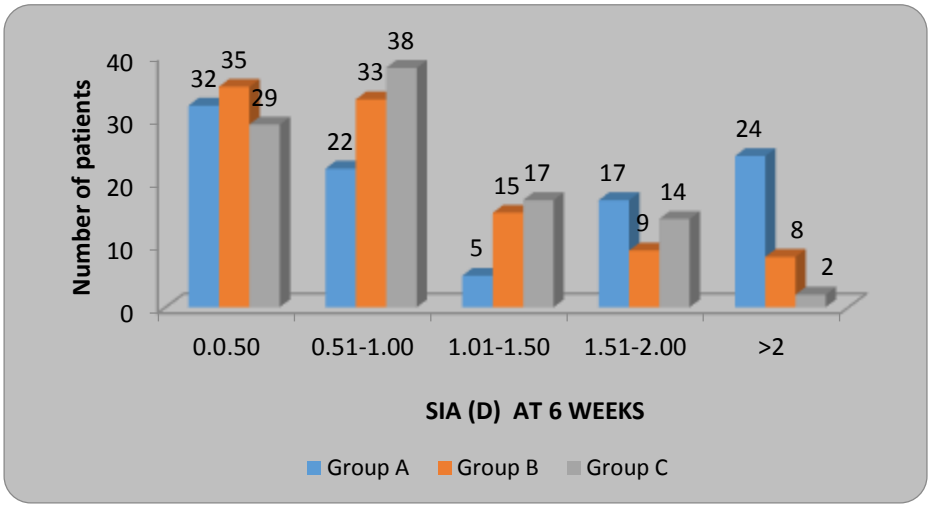
GRAPH 11.3

TABLE 12.4: SURGICALLY INDUCED ASTIGMATISM AT 6 WEEKS IN 3 GROUPS

SIA (D) AT 6 WEEKS	GROUP A (SUPERIOR INCISION)	GROUP B (SUPERO TEMPORAL INCISION)	GROUP C (TEMPORAL INCISION)	ϰ2-value	p-value
0.0.50	32	35	29	36.86	0.0001,S, p<0.05
0.51-1.00	22	33	38		
1.01-1.50	5	15	17		
1.51-2.00	17	9	14		
>2	24	8	2		
Total	100	100	100		
Mean ±SD	1.32±0.97	1.03±0.75	1.00±0.60		

The Mean surgically induced astigmatism in superior scleral incision group was 1.32±0.97, in superotemporal scleral incision group was 1.03±0.75 and in temporal scleral incision group, it was 1.00±0.60.

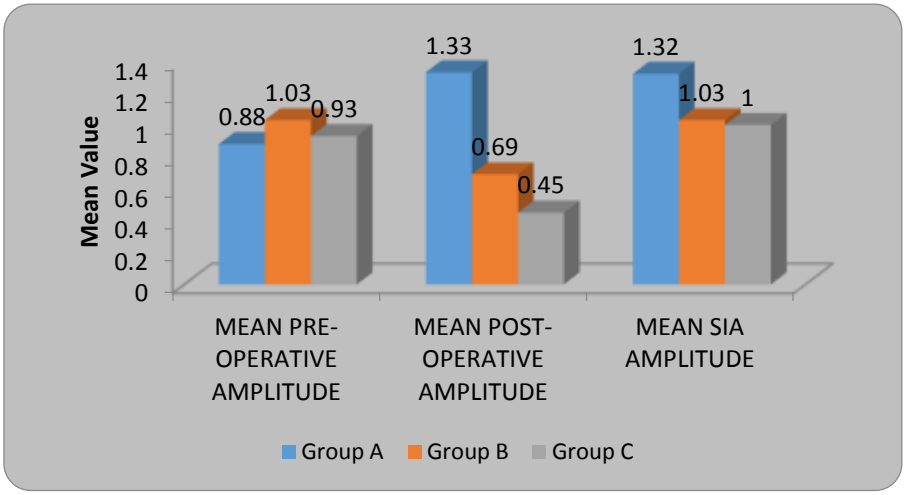
By using chi-square test, ϰ2-value is 36.86, p value=0.0001 shows that the difference in the 3 groups was statistically significant.



GRAPH 11.4

TABLE 13: AMPLITUDE OF ASTIGMATISM

AMPLITUDE OF ASTIGMATISM	GROUP A (SUPERIOR INCISION) (±SD)	GROUP B (SUPERO TEMPORAL INCISION) (±SD)	GROUP C (TEMPORAL INCISION) (±SD)	P VALUE
MEAN PRE-OPERATIVE ASTIGMATISM	0.88±0.62	1.03±0.66	0.93±0.62	1.54,p=0.21,NS
MEAN POST-OPERATIVE ASTIGMATISM AT 6 WEEKS	1.33±0.60	0.69±0.49	0.45±0.24	103.68,p=0.0001,S
MEAN SIA AMPLITUDE 6 WEEKS	1.32±0.97	1.03±0.75	1.00±0.60	4.09,p=0.018,S



GRAPH 12

TABLE 14: COMPARISION BETWEEN THE GROUPS

COMPARISION	MEAN DIFFERENCE	p-value	Significance
GROUP A vs GROUP B	0.28±0.11	0.029	S,p<0.05
GROUP A vs. GROUP C	0.32±0.11	0.011	S,p<0.05
GROUP B vs GROUP C	0.03±0.11	0.814	NS,p>0.05

This table shows the statistically significant difference when group A compared with group B and group A vs group C . Whereas, group B vs Group C didn't show any significance.
This result was similar to the previous study done by Vaishali Satyajeet Pawar (18)

TABLE 15: POST-OPERATIVE UNCORRECTED VISUAL ACUITY IN THREE GROUPS

TYPE OF INCISION	VISUAL ACUITY	POST-OP DAY 1	POST-OP 1 WEEK	POST-OP 1 MONTH	POST-OP 6 WEEKS
GROUP A (SUPERIOR INCISION) (n=100)	6/6-6/9	6	10	5	15
	6/12-6/18	32	32	83	79
	6/24-6/36	44	53	12	6
	≤ 6/60	18	4	0	0
GROUP B (SUPERO-TEMPORAL INCISION) (n=100)	6/6-6/9	3	2	5	25
	6/12-6/18	34	57	71	73
	6/24-6/36	55	40	24	2
	≤ 6/60	8	1	0	0
GROUP C (TEMPORAL INCISION) (n=100)	6/6-6/9	3	7	24	53
	6/12-6/18	44	65	69	47
	6/24-6/36	47	28	7	0
	≤ 6/60	6	0	0	0
ϰ2-value		12.83	29.72	33.43	40.76
p-value		0.04, S	0.0001,S	0.0001,S	0.0001,S

There was a gradual increase in the visual acuity in three groups from post-operative 1 day to 6 weeks. The data was statistically significant in the three groups.

DISCUSSION

The sutureless manual Small Incision Cataract Surgery (SICS) is a good alternative to Phacoemulsification and it gives visual results which are equivalent to Phacoemulsification, at lower expenses. But the rates of astigmatism are higher due to the larger sizes of the incisions. In order to achieve an excellent visual acuity, the effect of astigmatism on the postoperative vision has to minimize. Pre-existing astigmatism can be neutralized by changing the site of the incision.

The pre-operative astigmatic profile shows that ATR is the more common type of astigmatism. This is because in normal healthy eyes stiff upper tarsal plate causes pressure on cornea resulting in WTR but with increasing age, this pressure gradually decreases resulting in ATR. Similar findings were seen in a study done by Kavitha KNS (12), Sowbhagya HN(13).

It was observed that superior incision causes more ATR shift than the WTR, as the incision on the superior meridian cause's flattening of the vertical meridian and steepening of horizontal meridian leading to more ATR shift postoperatively, whereas in temporal and superotemporal incision there is more WTR shift because of flattening of horizontal meridian and steepening of vertical meridian.

A similar result was found in Renu M. Magdum (14), Gokhale NS, Swahney(15), Kavitha KNS(12).

In the present study, there was a significant difference in the amount of astigmatism between 3 groups on the first postoperative day. However, astigmatism gradually reduced in 3 groups and in 6 weeks there was a further reduction in the amount of astigmatism in both the groups, but the difference in both the groups was highly statistically significant ($p<0.001$).

These STUDY RESULTS ARE COMPARABLE WITH OTHER STUDIES AS SHOWN.

Study	Radwan AA (16)	Gokhale NS(15)	Malik VK et al(17)	Satyajeet V (18)	Present study
Superior	2.05±1.19	1.36±1.03	1.45±0.7	1.52±0.6	1.32±0.97
Supero-temporal	1.08±1.08	0.5±1.15	0.8.05±1.25	0.6±1.25	1.03±0.75
Temporal	0.7±0.52	0.40±0.4	0.75±0.4	0.43±0.33	1.00±0.60

The reduced visual acuity on the first post-op day in both groups is due to the corneal edema, anterior chamber reaction and greater amount of surgically induced astigmatism. But visual recovery is early in a temporal group than the superior group. Similar results were found in a study done by Vinay KV et al(19).

The early improvement in visual acuity in TI is due to the fact that temporal location is farther from the visual axis than superior location and any flattering due to wound is less likely to affect the corneal curvature at the visual axis.

When the incision is located superiorly, both gravity and eyelid blink tend to create a drag on the incision. These factors are neutralized well with temporally placed incision because the incision is parallel to the vector of forces.

Oshika T (20) evaluated the effect of superior and temporal scleral incisions on regular and irregular astigmatism in small incision cataract surgery and they concluded 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.

CONCLUSION

Surgically induced cataract surgery with the superior-temporal and the temporal approaches provides a better quality of vision due to the significantly less surgically induced astigmatism (SIA) than the superior approach.

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