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Effect of Surgical Incision Site on Astigmatism in Cataract Patients

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Abstract:
Objectives:
1. *To Know the Effect of location of incision site on surgically induced astigmatism.*
2. *To Evaluate the Pre and Postoperative astigmatic profile of cataract surgery patients*
Materials and Methods: *100patients undergone manual small incision cataract surgeries, were evaluated for pre and postoperative astigmatic profile and the effect of surgical incisions on the postoperative astigmatism during the period from June 2015 to June.2016. The incision was placed on the steep axis in cases where the astigmatism was >1D and either superiorly or temporally in cases where the astigmatism was <1D. The astigmatism was assessed by keratometry on 1st day, 1week, 6weeks and 12 weekspostoperatively.*
Results: *The sub-analysis of change in astigmatism in preoperative cases with ATR showed that in superior incision group the mean astigmatism increased from 0.81+/-0.65 to 1.50+/-0.5 and in the temporal incision group the mean astigmatism decreased from 1.45+/-0.5 to 1.05+/-0.2 post operatively. Thus in preoperative cases with ATR the superior incision showed an increase in astigmatism while a temporal incision showed decrease in astigmatism postoperatively. The sub-analysis of change in astigmatism in preoperative cases with WTRshowed that in superior incision group the mean astigmatism decreased from 1.15+/-0.6 to 0.70+/-0.5 and in the temporal incision group the mean astigmatism increased from 0.65+/-0.5 to 0.75+/-0.5 postoperatively. Thus in preoperative cases with WTR the superior incision showed a decrease in astigmatism while a temporal incision showed a minimal increase in astigmatism postoperatively.Conclusion:In MSICS,Superior incision causes ATR shift and temporal incision causes WTR shift and Temporal approach produces less astigmatism compared to superior incision.*
Keywords: *SIA(Surgery induced astigmatism), ATR (Against the rule), WTR(With the rule), MSICS(Manual small incision cataract surgery)*

I. Introduction

Manual small incision cataract surgery (MSICS) through a sclera-corneal tunnel has become a standard procedure with advantages of suture less wound closure, less astigmatism and less cost.Several variables exist in the creation of wounds of cataract surgery such as location, direction, width, depth and shape. Location of incision has a significant impact on surgical outcome. It has been reported that temporal incisions induce less astigmatism than superior incisions indicating the importance of incision location.Thus our study was conducted with the objective to study the effect of location of incision on preexisting preoperative astigmatism and postoperative surgically induced astigmatism.

Thomas Young[1] in 1801 was the first to describe ocular astigmatism, discovering that his own astigmatism was predominantly lenticular.Some years later in 1827 Airy[2] corrected astigmatism with a cylindrical lens.Helmholtz[3] (1854) introduced ophthalmometer to measure corneal curvature.Corneal astigmatism was characterized by Knapp and Donders[4] in 1862.Donder[5] in 1864 showed that an unwelcome consequence of cataract surgery is an alteration in corneal curvature.In a study conducted by Ahmad Abdelmegid Radwan[11] in 2011, the mean SIA was found to be significantly lower in temporal group compared to that in the superior group ($p<0.01$).In a study conducted by Mallik VK et al in 2012,SIA induced by the superior incision was 48.28 % more than by the temporal incision and SICS with the temporal approach provides a better stabilization of the refraction. Gokhale NS, Sahney [7]et al, in their study concluded that the superior incision resulted in more ATR shift whereas temporal incision resulted in WTR shift.Renu M Magdum et al[8]in their study also showed that SIA was more in superior incision group than temporal incision group. Jawed Alam et all[9]also showed in their study that SICS through temporal approach provides better stabilization of refraction with significantly lesser amount of SIA than superior approach.

Aims and Objectives:1.To know Effect of location of incision site on surgically induced astigmatism. 2. To evaluate the pre and postoperative astigmatic profile.

II. Materials and Methods:

This was a prospective study of 100 patients undergoing manual small incision cataract surgery at Sarojini Devi Eye Hospital, Hyderabad for a period of one year from June2015 toJune 2016.

Inclusion criteria was the cataract patients with regular astigmatism of with the rule astigmatism (WTR) and against the rule astigmatism(ATR)).Exclusion criteria were the cataract patients with Irregular astigmatism, Traumatic cataract, Corneal dystrophies and degenerations.For all patients thorough preoperative evaluation done,i.e preoperative keratometry, slit lamp examination of anterior segment, fundus examination with 90D and A scan. The postoperative astigmatism was assessed by keratometry on 1stday, 1week, 6weeks and 12 weeks postoperatively.The incision was placed on the steep axis where the astigmatism was>1D .In cases where the astigmatism was <1D, the incision was placed either superiorly or temporally.

Procedure:

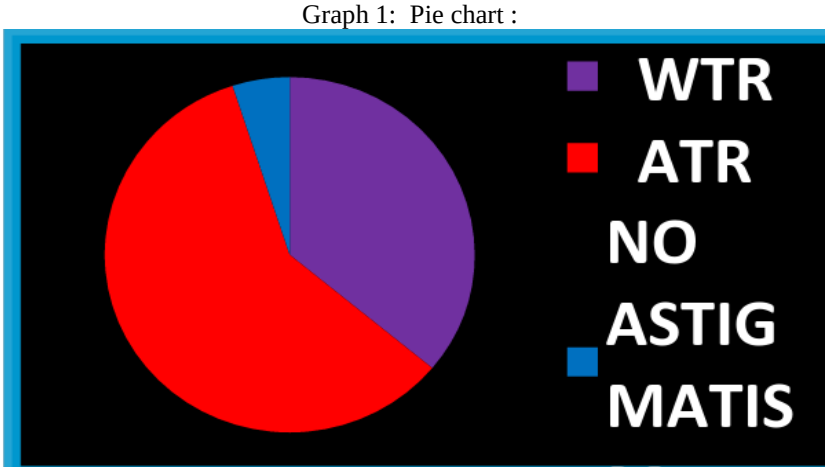
After preparing the eye for surgery, fornix based conjunctival flap was taken at superior or temporal limbus and gentle cautery was done. A frown shapedscleral incision of about 6-6.5mm was placed 2mmbehind the limbus superiorly or temporally. Dissection of sclerocorneal tunnel was done with crescent blade up to 1.5mm into thecornea. A side port was made at 10' or 1' o clock position. Viscoelastic was injected into anterior chamber and a continuous curvilinear capsulorrhexis approximately 5 mm was done with cystitome through side port. Then the sclerocorneal tunnel was completed using 3.2mm keratome and extended to 6-6.5mm. The internal corneal opening was made 1-2mm larger than external opening.Thorough hydrodissection was done and nucleus was prolapsed into the anterior chamber and viscoelastic was injected in front and behind the lens nucleus. Lens nucleus was delivered out using sandwich technique using vectis and Sinskey Hook. Remaining cortical matter was removed with Simcoe cannula and 6mm optic (overall 12.5mm) PMMA single piece posterior chamber lens was inserted in the capsular bag. The remaining viscoelastic was aspirated and the anterior chamber was reformed with BSS through the side port.The main wound was checked for any leakage, then conjunctiva was closed using cautery.Post-operative treatment included topical steroid & antibiotic combination for a week followed by only topical steroid in a tapering dose for 5 wks. Patients were examined on I POD, I wk, 6 wks and 12 wks for keratometry readings.

Observation and Results:

Table 1 : Preoperative astigmatic profile of cataract patients :

S.No	Type of astigmatism	No of patients	%
1	WTR	36	36.0
2	ATR	59	59.0
3	No astigmatism	5	5.0
Total		100	100.0

Graph 1: Pie chart :

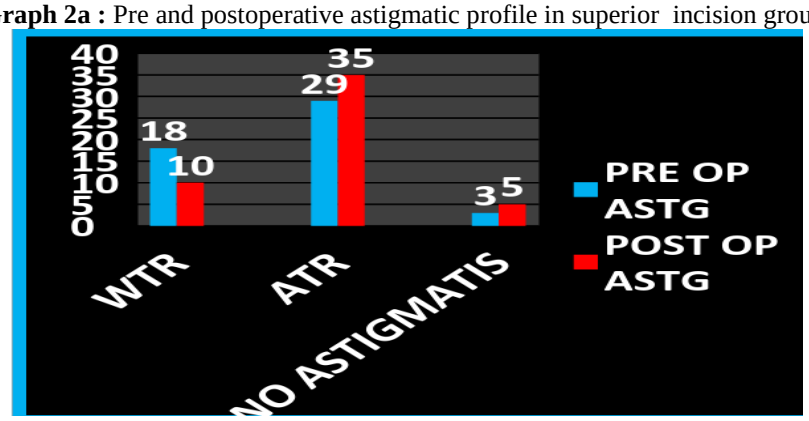


Preoperative astigmatic profile shows that ATR is more common type of astigmatism than WTR and astigmatically neutral cases in older age group.

Table 2: Pre and postoperative astigmatic profile in superior and temporal incision groups (No. of cases)

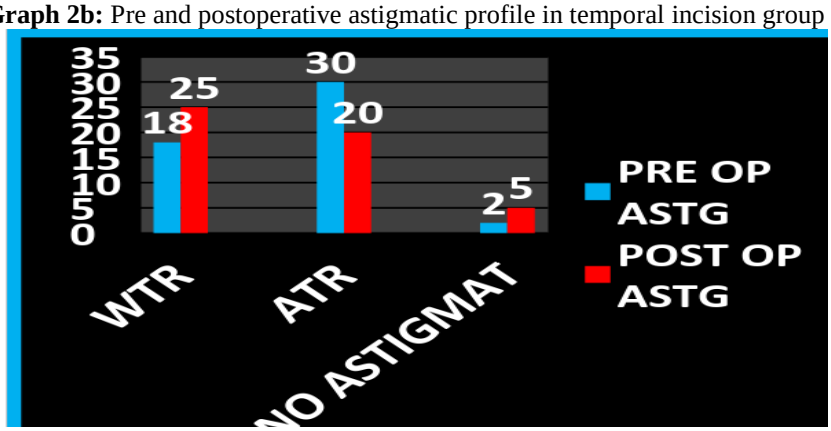
S.No	Type of astigmatism	Superior incision		Temporal incision	
		Preoperative	Postoperative	Preoperative	Postoperative
1	WTR	18	10	18	25
2	ATR	29	35	30	20
3	No Astigmatism	3	5	2	5
4	Total	50	50	50	50

Graph 2a : Pre and postoperative astigmatic profile in superior incision group



Superior incision causes more ATR shift than WTR, as the incision on the superior meridian causes more flattening of the vertical meridian and steepening of the horizontal meridian leading to more ATR shift postoperatively,

Graph 2b: Pre and postoperative astigmatic profile in temporal incision group :

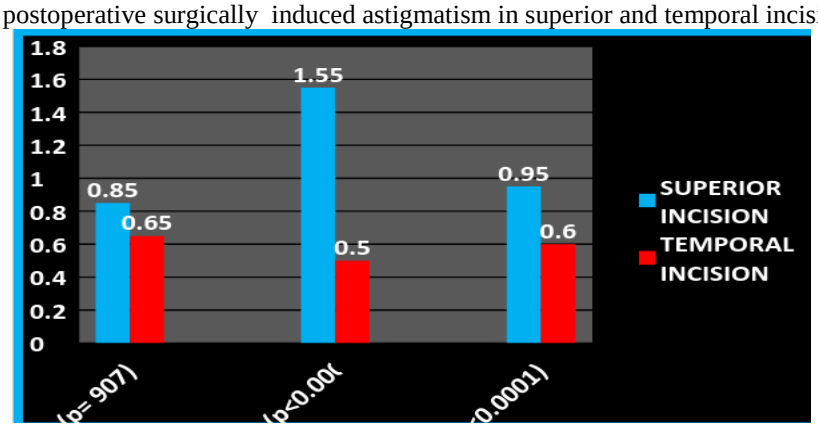


In temporal incision the shift of astigmatism was more towards WTR as more flattening of horizontal meridian and steepening of the vertical meridian leading to more WTR shift. This is advantageous as most of the patients in older age will have ATR.

Table 3: Pre and postoperative surgically induced astigmatism in superior and temporal incision groups :

Mean Astigmatism(D)	Superior incision	Temporal incision	P-Value
Preoperative	0.85+/-0.75	0.65+/-0.35	P =0.907
Postoperative (6 wks)	1.55+/-1.15	0.50+/-0.35	P<0.0001
Mean SIA (D)	0.95+/-0.5	0.60+/-0.5	P<0.0001

Graph 3 : Pre and postoperative surgically induced astigmatism in superior and temporal incision groups

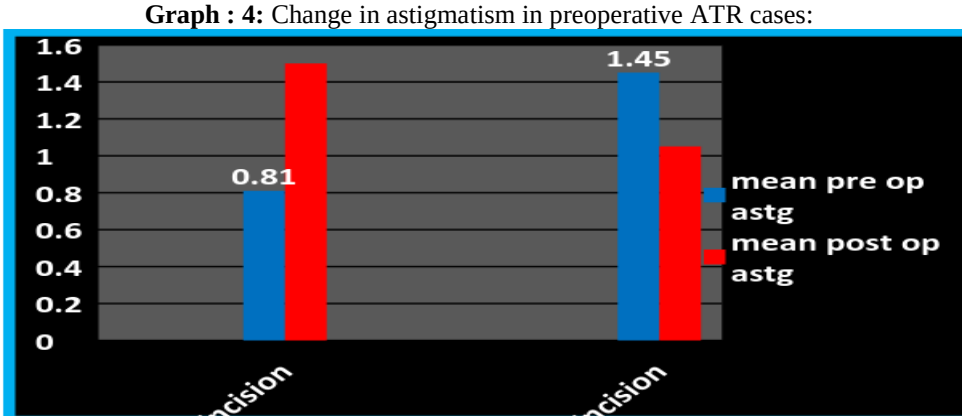


There is no statistically significant difference in the mean preoperative astigmatism in both the groups.There isa significant difference in postoperative astigmatism between superior and temporal groups.
The mean SIA was more in superior incision group than temporal incision.

Table 4: Change in astigmatism in preoperative ATR cases:

Type of incision	Mean preoperative astigmatism	Mean postoperative Astigmatism
Superior incision	0.81+/-65	1.50+/-0.5
Temporal incision	1.45+/-0.5	1.05+/-0.2

Graph : 4: Change in astigmatism in preoperative ATR cases:

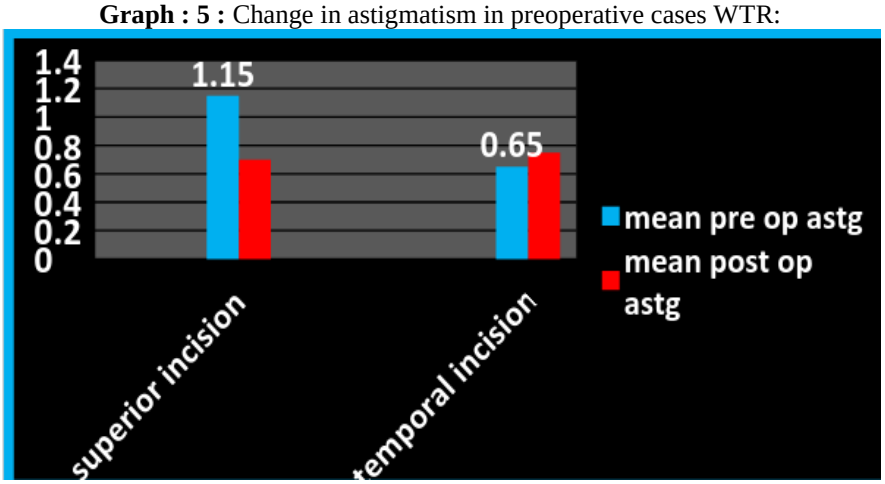


In cases with ATR the superior incision showed an increase in post operative astigmatism while a temporal incision showed decrease in astigmatism showing that placing the incision in flat axis increases the astigmatism and if it is placed on the steep axis it decreases the astigmatism.

Table 5: Change in astigmatism in preoperative cases WTR :

Type of incision	Mean preoperative astigmatism	Mean postoperative Astigmatism
Superior incision	1.15+/-0.6	0.70+/-0.5
Temporal incision	0.65+/-0.5	0.75+/-0.5

Graph : 5 : Change in astigmatism in preoperative cases WTR:



In preoperative cases with WTR, the superior incision showed a decrease in astigmatism while a temporal incision showed an increase in astigmatism postoperatively showing that placing the incision on flat axis increases the astigmatism and on the steep axis decreases the astigmatism.

III. Discussion

MSICS is the first choice alternative to phacoemulsification. Its advantages are visual results equivalent to phacoemulsification at a lower cost. It is the surgery for the masses and appropriate for a developing country, as it is cheap, fast, safe and easy to learn and needs fewer resources. However, the larger incision used induces greater astigmatism than phacoemulsification. High astigmatism is an important cause of poor uncorrected visual acuity after cataract surgery. This study was done with the aim to study the effect of location of incision on pre-existing and surgically induced astigmatism.

In our study, based on the preoperative keratometric values, the incision was placed on the steep axis where the astigmatism was>1D .In cases where the astigmatism was <1D, the incision was placed either superiorly or temporally. As we know from the review of literature on relation between location of incisionand astigmatism, placing the incision on flat axis increases the astigmatism and if it is placed on the steep axis it

decreases the astigmatism. Therefore in cases where the astigmatism was > 1D, incision was placed on the steep axis to avoid further increase in the amount of astigmatism.

In our study out of the total 100 patients undergoing MSICS, 59 patients had ATR, 36 patients had WTR and 5 patients had no astigmatism. Thus the preoperative astigmatic profile shows that ATR is more common type of astigmatism in this group of patients undergoing cataract surgery group. This is because in normal healthy eyes stiff upper tarsal plate causes pressure on cornea resulting in with the rule astigmatism but with increasing age this pressure gradually decreases resulting in against the rule astigmatism.

Among 50 patients in superior incision group, preoperatively18 had WTR, 29 had ATR and 3 did not have astigmatism. Post operatively the no of patients with WTR decreased to10 and with ATR increased to 35 showing that superior incision flattens vertical meridian and steepens the horizontal meridian causing ATR shift. Among 50 patients in temporal incision group, preoperatively18 had WTR, 30 had ATR and 2 did not have astigmatism. Post operatively the no of patients with WTR increased to 25 and with ATR decreased to 20 showing that temporal incision flattens horizontal meridian and steepens the vertical meridian causing WTR shift.

This is explained by the fact that flattening of the cornea occurs at direction right angles to direction of cataract incisions. During healing process of sclera-corneal incision proliferating fibrous tissue begins to form, running at right angles to the clear cut scleral edges and when the fibrous tissue contracts, flattening occurs at direction right angles to the direction of cataract incisions with consequent steepening of the opposite meridian. Therefore, superior incision flattens vertical meridian and steepens horizontal meridian. Temporal incision flattens horizontal meridian and steepens vertical meridian. This effect is more marked in the superior incision than temporal incision as the superior incision is closer to the visual axis than temporal incision.

In our study the mean preoperative astigmatism in superior incision group was 0.85+/-0.75 which increased to 1.5+/-1.15 post operatively. The mean postoperative astigmatism in temporal incision group was 0.65+/-0.35 which decreased to 0.50+/-0.35 post operatively. Thus the postoperative astigmatism is more in superior incision group than temporal incision group. Our study shows that there is no statistically significant difference in the mean pre-operative astigmatism in superior (0.85+/-0.75) and temporal incision(0.65+/-0.35) groups ($p=0.907$). There is a statistically significant difference between the superior and temporal incision in postoperative astigmatism ($p<0.0001$) with the superior incision showing more astigmatism than the temporal group. The mean SIA was more in superior incision group than temporal incision ($p<0.0001$).This is because farther the incision from the visual axis less is the flattening effect on corneal curvature. Temporal incision is farther from the visual axis than the superior incision because the corneal diameter is greater in horizontal meridian than vertical meridian.

In a study conducted by Renu M Magdum et al[12], to evaluate the amount and type of surgically induced astigmatism in superior and temporal scleral incision inMSICS, a total of 100 eyes were operated for cataract by MSICS. 50 eyes were operated by superior scleral incision and 50 by temporal scleral incision. There was no significantdifference between the superior and temporal incision group in age, sex, preoperativekeratometric astigmatism and corrected visual acuity. The Astigmatic profile preoperatively showed that 38% of the patients had WTR, 56% of the patients had ATR and 6% had no astigmatism, which are comparable to our results. The astigmatic profile postoperatively showed, in the superior incision group the no of patients with WTR decreased from 21 to 8 and with ATR increased from 26 to 37. In the temporal incision group the no of patients with WTR increased from 17 to 29 and with ATR decreased from 30 to 18. The results showed that postoperatively, in superior scleral incision group of 50 eyes, 74% patients had ATR astigmatism and 16% patients had WTR astigmatism, whereas in temporal scleral incision group of 50 eyes, 56 % of the patients had WTR astigmatism and 36 % had ATR astigmatism. Mean SIA in temporal incision group was 0.62 D + 0.72 and in superior incision was 0.95 D + 0.68. This concludes that superior incision causes ATR shift and temporal incision causes WTR shift. This study concluded that temporal approach MSICS produces less postoperative astigmatism and has manifold advantages over superior incision MSICS with excellent visual outcome. Thus the results of the above study are comparable to our study.

In a study conducted by Gokhale NS, Sahney et al[13]to study the reduction in astigmatism in manual small incision cataract surgery through change of incision site, forty-five eyes of 42 patients (24 Male / 18 Female) with a mean age of 55.4 years (range 29 - 72 years) were included. They were subdivided randomly into three groups of 15 eyes each. Group A received superior incision, group B received supero-temporal incision and group C eyes received a temporal incision. The data were analyzed using Cartesian coordinates based analysis using Holladay's system.The amplitude of preoperative astigmatism was similar and around 0.5 D in the three groups. The amplitude of postoperative astigmatism was higher in group A (1.45 + 0.94) than in group B (0.43 + 0.27) and in group C (0.67 + 0.65). The amplitude of surgically induced astigmatism was also higher in group A (1.36 + 1.03) than in group B (0.51 + 0.49) and in group C (0.40 + 0.40). Thus the study concludes that SIA is more in superior incision when compared to temporal and supero-temporal incision.The results showed that 1.28 D of horizontal steepening (or vertical flattening) was induced by making a superior

incision and temporal incision induced an average horizontal flattening (or vertical steepening) of about 0.37 D, concluding that superior incision causes ATR shift and the temporal incision causes WTR shift. This was comparable to our results..

In a study conducted by Jawed Alam, Himadri Bhattacharjya et al[14], to compare surgery induced astigmatism in manual small incision cataract surgerythrough superior and temporal approaches, 130 eyes were operated, with 65 in superior incision group and 55 in the temporal incision group. The results showed that, the mean SIA in temporal incision group was 0.70D + 0.30and in superior incision was 1.45+0.40. The study concludes that SICS through temporal approach provides better stabilization of refraction with significantly lesser amount of SIA than the superior approach.Thus the results from the above studies support our study.

In a study conducted by Mallik VK, Kumar S et al[15], to compare astigmatism induced by the superior and temporal section in manual small incision cataract surgery (SICS) in the Indian population, 110 eyes were operated. Eyes having a steeper vertical keratometry reading were assigned to the superior SICS group whereas eyes with a steeper horizontal keratometry reading were assigned to the temporal SICSgroup. Eyes with no astigmatism were randomly assigned to either of the two groups.Both the groups had 54 eyes each. Eyes in Group 1 underwent manual SICS with a superior tunnel and eyes in Group 2 underwent manual SICS with a temporal tunnel. The results showed that the mean SIA in Group1 was found to be 1.45 +/- 0.7387 and in Group 2 it was 0.75+/-0.4067. The SIA induced by the superior incision was 48.28 % more than by the temporal incision. Thus the study also concluded that SICS with the temporal approach provides a better stabilization of the refraction with a significantly less SIA than superior approach. The above study also shows that SIA is more with superior incision group than temporal incision group, which is comparable to our results.

In a study conducted by Vaishali Satyajeet Pawar, D. K. Sindal et al[16], to compare the amount of surgically induced astigmatism after the superior, supero-temporal and the temporal incisions in manual small incision cataract surgery, 300 patients were studied. The patients were randomly assigned to any of threegroups. The three groups had 100 patients each. The group A patients underwentmanual SICS with a superior incision, the group B patients underwent manual SICS with a supero-temporal incision and the group C patients underwent manual SICS with a temporal incision. All the calculations were performed by using the Surgically-Induced Astigmatism (SIA) calculator version 2.1, a free software program. The results showed that the mean SIA in groupA was found to be 1.572 ± 0.651, in group B 0.532± 0.317and in group C 0.435 ±0.338. Thus the study also concluded that SICS done with a temporal and a supero-temporal approach provides a better quality of vision due to a significantly less SIA than the superior approach. The results in our study are consistent with this study though we have studied only the comparison between superior and temporal incision and used subtraction method for analysis of astigmatism.

In a study conducted by Tetsuro Oshika, Gentaro Suquita et al[17], to evaluate the effect of superior and temporal scleral incisions on regular and irregular astigmatism in small incision cataract surgery, 174 eyes of 87 patients with bilateral cataracts were scheduled to undergo routine cataract surgery. One eye of each patient was randomly assigned to the superior incision group and the contralateral eye was allocated to the temporal incision group with Surgically-induced regular astigmatism calculated by vector analysis method and irregular astigmatism obtained by Fourier analysis of videokeratography data. The postoperative results showed in the superior incision group slight against-the-rule astigmatic changes and slight with-the-rule astigmatism in the temporal incision group. The amount of against-the-wound astigmatism and absolute value of length of the induced vector did not differ significantly between groups ($P > 0.05$, paired t test). In both groups, irregular astigmatism 1 day after surgery was significantly greater than the preoperative levels ($P < 0.001$), but not thereafter. No significant intergroup difference was observed in the amount of irregular astigmatism at any postoperative visits ($P > 0.05$). There was no significant difference in uncorrected and corrected visual acuity between groups postoperatively ($P > 0.05$, chi-square test).The study concludes that in small scleral incision cataract surgery, superior and temporal approaches are comparable in terms of visual rehabilitation and induction of regular and irregular astigmatism. The results of this study do not support the results of our study as it shows that SIA is comparable between superior and temporal incisions.

In a study conducted by Hemlata Yadav, Vaishali Rai et al[18] , to compare the astigmatism following MSICS : superior versus temporal approach, 216 cataract patients admitted in hospital underwent manual small incision cataract surgery. The results showed that the mean SIA in group 1 was found to be 1.37 ± 0.65and in group 2 was 0.67± 0.40. T-test was applied to compare the two groups. It was found to be highly significant (P value <0.001). SIA induced by superior incision was 45.28 % more than temporal incision.Thus this study also concluded that SICS with the temporal approach provides a better stabilization of the refraction with a significantly less SIA than superior approach. Thus the above study supports the results of our study.

In our study the sub-analysis of change in astigmatism in cases with ATRshows that in superior incision group the mean astigmatism increased from 0.81+/-o.65 to 1.50+/-0.5 post operatively and in the temporal incision group the mean astigmatism decreased from 1.45+/-0.5 to 1.05+/-0.2 post operatively. Thus in

cases with ATR the superior incision showed an increase in postoperative astigmatism while a temporal incision showed decrease in astigmatism.

In our study the sub-analysis of change in astigmatism in cases with WTR shows that in superior incision group the mean astigmatism decreased from 1.15+/-0.6to 0.70+/-0.5 post operatively and in the temporal incision group the mean astigmatism increased from 0.65+/-0.5 to 0.75+/-0.5 post operatively. Thus in cases with WTR the superior incision showed a decreased in postoperative astigmatism while a temporal incision showed a minimal increase in astigmatism.

This shows that placing the incision on flat axis increases the astigmatism and on the steep axis it decreases the astigmatism. Thus simple change in the location of incision can be used as a factor to minimize the pre-existing astigmatism and reduce the SIA

IV. Conclusion

Preoperative astigmatic profile shows that ATR is more common type of astigmatism than WTR .Superior incision causes ATR shift and temporal incision causes WTR shift.Temporal approach MSICS produces less postoperative astigmatism compared to superior incision.Placement of incision on steep axis reduces preexisting astigmatism. Thus in ATR astigmatism it is placed temporally and in WTR astigmatism it is placed superiorly.Thus a simple modification in incision placement can minimize surgically induced astigmatism and reduce preexisting astigmatism. Hence all cataract surgeons should familiarize with temporal incision in cataract surgery.

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