IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 11 Ver. 1 (November. 2018), PP 11-18
www.iosrjournals.org

Outcome of Clear Corneal Incision on Steep Meridian in Eye with Pre Existing Corneal Astigmatism after Phacoemulsification

Dr. Archana Thool[1], Dr. Sachin Daigavane[2]
1- Assistant Professor, 2- Professor & Head, Dept. of Ophthalmology, JNMC, Sawangi, Wardha
Corresponding author: Dr. Archana Thool

Abstract-
Purpose*: To study the outcome of clear corneal incision on steep meridian in eye with pre existing corneal astigmatism after phacoemulsification.*
Method*: It was a rural hospital based, prospective, interventional study which included 84 eyes of 84 patients with immature cataract and pre existing corneal astigmatism of up to 1.5 D who underwent 3.2 mm clear corneal phacoemulsification procedure either superior incision in patients having WTR or temporal incision in patients having ATR by single surgeon.*
Thus patients were grouped in two categories depending upon type of pre operative corneal astigmatism. Superior incision and temporal incision, each had 42 patients. The data was analyzed by chi-square test and p value < 0.05 was considered significant.The preoperative & postoperative UCVA, preoperative and postoperative corneal astigmatism at 6 weeks were compared in the both the groups. The SIA at 6 weeks was compared between the two groups. SIA was calculated by SIA calculator version 2.1 free online software.
Results*: There was statistically significant difference (P value= 0.0001) between preoperative and postoperative UCVA in both superior and temoral incision, suggestive of better postoperative UCVA. Mean preoperative astigmatism in superior incision group was*
0.79±0.26 and mean postoperative astigmatism was 0.47±0.32, (P value = 0.02) which was statistically significant. Mean preoperative astigmatism in temporal incision group was
0.76±0.28 and mean postoperative astigmatism was 0.45±0.28, (P value= 0.03) which was statistically significant. The mean SIA in superior incision group was 0.68±0.22 D and in temporal was 0.55±0.20 D. P value was 0.029. Thus SIA by temporal incision was less than superior incision.
Conclusion*: By placing incision on steep meridian there was significant reduction of corneal astigmatism postoperatively in majority of patients and hence better UCVA .The SIA by superior and temporal incision showed that temporal incision has less SIA than superior incision.*
Key words: *Pre existing astigmatism, steep meridian, surgically induced astigmatism.*

Date of Submission: 20-10-2018 Date of acceptance: 03-11-2018

I. Introduction

Cataract affects approximately 20 million people worldwide and figure is expected to reach 50 million by year 2020.[1,2] In India, in 2001- 7.75 million people were affected and figure is expected to reach 8.25 million by the year 2020.[3]

With a plethora of cataract surgeries available from intra-capsular cataract extraction to laser assisted cataract surgeries, it becomes imperative to sort between the different surgeries as to which is more effective in particular setting.

With advent of phacoemulsification and progressively decrease in size of surgical incision taken, cataract surgery has been changed into refractive surgery.[4] Phacoemulsification has advantages such as early visual rehabilitation, less induced astigmatism, and no suture related complications. Cataract surgery performed by phacoemulsification, results in better postoperative visual acuity than extracapsular cataract surgery at all postoperative interval.[5] It is currently the most performed planned surgical procedure worldwide, positively impacting over patients quality of life.[6]

Astigmatism is a visually disabling refractive error affecting general population, especially those with cataract.[1,6] Patients undergoing cataract surgery may have varying amount of corneal astigmatism. In addition to being a therapeutic procedure, cataract surgery is currently considered as a surgical approach for refractive errors.[6]

Factors affecting postoperative visual acuity outcome in terms of astigmatism are pre existing astigmatism, surgically induced astigmatism and post operative astigmatism. The advent small surgical incision

for cataract surgery and use of foldable IOL's has successfully managed to control or minimize the surgical induced astigmatism.

However post operative astigmatism still remains an obstacle in eyes with significant pre existing corneal astigmatism affecting postoperative uncorrected visual acuity.[7]

The visual outcome of surgery is mainly attributed to degree of postoperative astigmatism which in turn depends on the type, length, and position of incision and also on the method of wound closure. The spherical refractive error can be eliminated through a meticulously performed IOL power calculation while minimizing the post operative corneal astigmatism during cataract surgery involves management of two important aspects: PEA and SIA.[8]

The surgeon has a number of options for the intraoperative management of corneal astigmatism, which include the following:[5,9]

1. Placement of surgical wound along the steep axis of astigmatism.
2. Limbal relaxing incisions.
3. Toric IOL.
4. Astigmatic keratotomy
5. Opposite clear corneal incision
6. Two-stage procedure with excimer laser ablation.

It has been proposed that by placing the incision on steep meridian by marking the magnitude of PEA, we can cause reduction in SIA. The making of incision on steep meridian causes flattening in that meridian and a corresponding steepening in the opposite meridian to reduce the astigmatism.[10,11]

Thus modern cataract surgery aims to obtain an astigmatism free eye postoperatively regardless of preoperative astigmatism. Thereby to achieve excellent uncorrected visual acuity and less spectacle dependency postoperatively.

The purpose of our study is to see the effect of an incision placed on the steepest meridian in controlling / lowering the corneal astigmatic outcome in eyes with pre existing corneal astigmatism of up to 1.5 D based on hypothesis that making incision on the steep meridian leads to corneal flattening of same meridian.

II. Material And Methods:

The study was Rural hospital based prospective, interventional study conducted between September 2017 to march 2018 in the Department of Ophthalmology at Acharya Vinoba Bhave Rural Hospital attached to Jawaharlal Nehru Medical College, Sawangi (Meghe) Wardha, a constituent college of DattaMeghe Institute of Medical Sciences (Deemed to be University), Nagpur.

For this case 84 eyes of 84 patients with uncomplicated immature cataract (i.e nuclear sclerosis upto grade III by LOCS II classification, cortical cataracts, posterior Sub-capsular cataracts) and Patients with pre operative regular corneal astigmatism between 0.5 D and 1.5D attending ophthalmology OPD were included. Patients with complicated cataract, traumatic cataract, subluxated cataract, co existing glaucoma, pseudoexfoliation , corneal pathology, pterygium, patients with any retinal pathology and patients not giving informed consent were excluded from the study.

Informed consent was obtained from all subjects and procedure of the study were described to them. The study was approved by the Ethics and Research committees of DMIMS (DU) and was carried out in accordance with the tenets of the Declaration of Helsinki.

Patients were divided into 2 groups depending upon the type of PEA i.e WTR (90±20 degrees; (70 degrees-110 degrees axis)) or ATR – (180±20 degrees (160 degrees-20 degrees axis) astigmatism. Group A includes, 42 patients, with steep vertical meridian{WTR}, who underwent 3.2mm superior clear corneal incision phacoemulsification cataract surgery. Group B includes, 42 patients with steep horizontal meridian{ATR}, who underwent 3.2mm temporal clear corneal incision phacoemulsification cataract surgery. Foldabale IOL was implanted in all the cases. The 2 groups were then studied in terms of, change in preoperative and postoperative visual acuity at postoperatively 6 weeks. Also in terms of change in preoperative and postoperative keratometric astigmatism in dioptres, SIA in dioptres, and magnitude of SIA by superior and temporal clear corneal incision at the end of 6 weeks.

Pre operative evaluation

The pre-operative assessment of the each subject was done in terms of detailed history, Uncorrected visual acuity, detailed ocular examination of anterior and posterior segment, Pre-operative IOP, Sac syringing.

Pre-operative keratometric reading was taken for all the cases with the help TOPCON Autokeratometer (KR8900) in dioptres. The axial length and IOL power calculation was 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 II

classification. The amount and type of astigmatism was noted in all patients. Routine blood investigation was done.

Surgical technique

The Operating eye was dilated with Topical tropicamide 0.8% with phenylephrine 5% and also flurbiprofen (non-steroidal anti-inflammatory) eye drops were instilled every 15 minutes, 1 hour before the surgery for the maintenance of dilatation. All the surgeries were performed under peribulbar anaesthesia by single surgeon.

The steep meridian was marked with the surgical marking pen. Two side port were made with mvr blade depending on main incision site. Anterior capsulotomy was done by continuous curvilinear capsulorrhexis method using 26 no. Needle cystitome after filling the anterior chamber with viscoelastic substance. For steep vertical meridian, superior self sealing and for steep horizontal meridian, temporal self sealing, 3 step clear corneal incision was made at 12 o'clock using 3.2 mm keratome. Hydrodissection and hydrodelineation was done, nucleus was rotated freely in capsular bag. Phacoemulsification of nucleus was done by stop and chop method and in cases with soft cataract flip and chop method was used. Remaining cortex was aspirated by bimanual irrigation and aspiration. Foldable IOL was implanted in the capsular bag with the injector. Anterior chamber wash was given and the main incision and side ports were sealed by hydration.

Antibiotic eye drop Moxifloxacin 0.5%) was instilled and eye was padded. Post-operatively all the subjects were given oral antibiotics for 5 days and topical combination antibiotic and streroid(Dexamethasone (0.1%) + Moxifloxacin (0.5%)) eye drop initially 2 hourly for 2 days, followed by 6 times/ day for 1 week then tapered off for 6 weeks post operative.

Post operative evaluation

Each subject was followed up post-operatively on day 1st, 1st post-operative week, 4th week and 6thweek. At each of the follow up, patient were examined for Uncorrected Visual acuity by Snellen's chart or Landolt C chart in illiterate patients along with detailed ocular examination. Post-operative keratometry was done at the end of 6^{th} week by autokeratometry in diopters. For simplification of analysis all astigmatic changes were studied only in the vertical and horizontal meridian. Amplitude of pre-operative and post-operative astigmatism was calculated from the difference in the keratometric value in the steeper and flatter meridian, using the plus cylinder notation. SIA was performed using SIA calculator version 2.1, a free soft ware program.(By Dr Saurabh Swahney and Aashima Aggarwal 2010)

Statistical analysis

Statistical analysis was done by using descriptive and inferential statistics using Chi square test. Analysis was done by using SPSS software (Statistical Package for the Social Sciences, version 22.0) and Graph Pad Prism 6.0 version software Statistical significance was considered when the p value was <0.05.

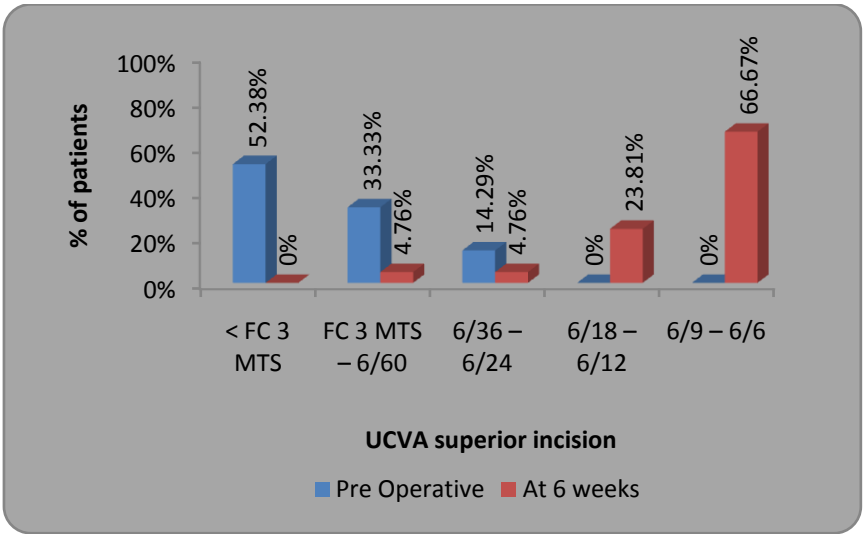
III. Results

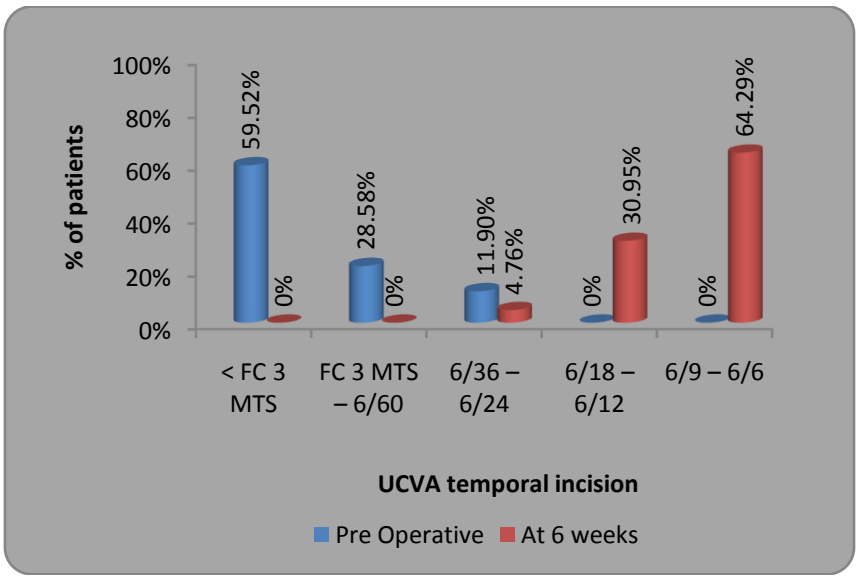
- A total 84 eyes of 84 patients were included in the study.The age ranged from 22 to 82 and mean age of the patients was 61.86± 10.38 yrs, majority of patients were in the range of 51 to 70 yrs.
- Genderwise, 49% were male and 51% were female.
- On the basis of laterality of eye,49% were right eye and 51% left eye..
- Distribution of patients according to grade of cataract were, In present study distribution of patients according to type of cataract were, NS I (5%), NS II (21%), NSIII (26%), NS II + PSC (23%), NSIII + PSC (20%) & PSC (5%).
- There was no statistically significant difference between 2 groups according to age, gender, laterality of eye and distribution of grade of cataract.
- Table 1 shows preoperative and post operative UCVA for the two groups. There was a statistically significant difference in the pre operative and the post operative UCVA at 6 weeks of the patients in both the groups.

Table 1

UCVA	Pre operative UCVA	Postoperative UCVA 6 weeks	X^2-value
Superior incision			
< FC 3 MTS	22(52.38%)	0(0%)	71.00 p=0.0001,S
FC 3 MTS – 6/60	14(33.33%)	2(4.76%)	
6/36 – 6/24	6(14.29%)	2(4.76%)	
6/18 – 6/12	0(0%)	10(23.81%)	
6/9 – 6/6	0(0%)	28(66.67%)	

Temporal incision			
< FC 3 MTS	25(59.52%)	0(0%)	75.28 p=0.0001,S
FC 3 MTS – 6/60	12(28.58%)	0(0%)	
6/36 – 6/24	5(11.90%)	2(4.76%)	
6/18 – 6/12	0(0%)	13(30.95%)	
6/9 – 6/6	0(0%)	27(64.29%)	



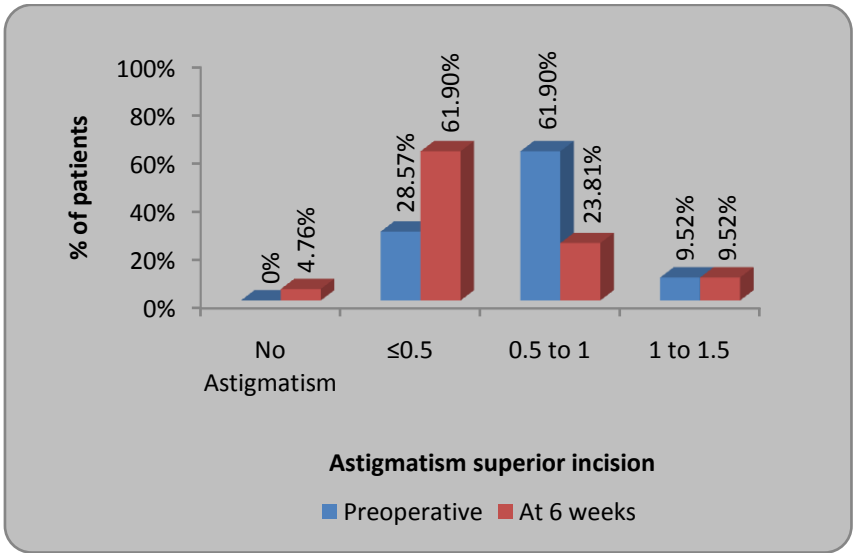


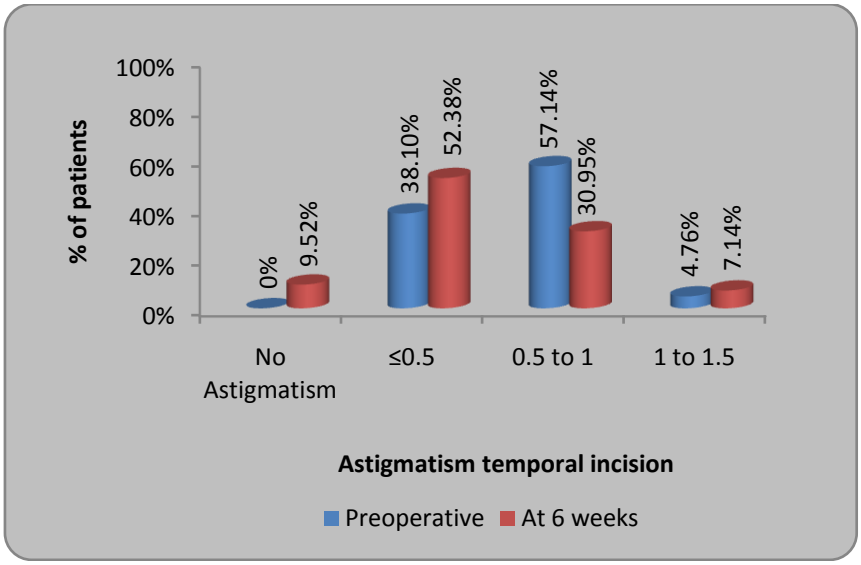
- Table 2 shows the comparison of preoperative and post operative corneal astigmatism in superior and temporal incision group. There was a significant difference in the post operative astigmatism at 6weeks in both the groups.

Table 2

Astigmatism	Preoperative	At 6 weeks	χ2-value
Superior incision			
No Astigmatism(0)	0(0%)	2(4.76%)	14.27 p=0.02,S
≤0.5	12(28.57%)	26(61.90%)	
0.5 to 1	26(61.90%)	10(23.81%)	
1 to 1.5	4(9.52%)	4(9.52%)	
Mean ± SD	0.79±0.26	0.47±0.32	
Temporal incision			
No Astigmatism(0)	0(0%)	4(9.52%)	8.41 P=0.03,S
≤0.5	16(38.10%)	22(52.38%)	

0.5 to 1	24(57.14%)	13(30.95%)	
1 to 1.5	2(4.76%)	3(7.14%)	
Mean ± SD	0.76 ± 0.28	0.45 ± 0.28	





- Table 3 shows comparison of SIA in superior and temporal incision. The mean SIA in superior incision group was 0.68±0.22 D and in temporal was 0.55±0.20 D. P value was 0.029. Thus SIA by temporal incision was less than superior incision.
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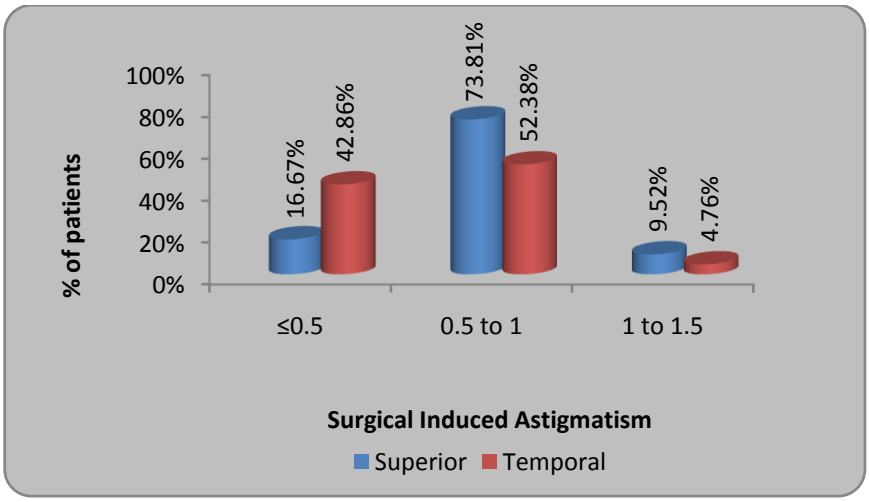
Table 3

SIA(D)	Superior	Temporal	χ2-value
≤0.5	7(16.67%)	18(42.86%)	
0.5 to 1	31(73.81%)	22(52.38%)	7.03
1 to 1.5	4(9.52%)	2(4.76%)	p=0.029,S
Mean±SD	0.68±0.22	0.55±0.20	



IV. Discussion

- Cataract surgery is one of the most gratifying surgical procedure in ophthalmology.
- With advent of phacoemulsification technique, progressively decrease in size of surgical incision taken and availability of various refractive IOLs, cataract surgery has become more of "refractive surgery" rather than rehabilitative surgery.
- Patients undergoing cataract surgery may have varying amount of corneal astigmatism. Also there is varying amount of corneal astigmatism induced by the surgical incision. Both these factors can lead to significant postoperative corneal astigmatism thus affecting the excellent final postoperative UCVA even after uneventful cataract surgery.
- Thus to decrease postoperative corneal astigmatism during cataract surgery involves management of pre existing corneal astigmatism which is intrinsic to the cataract patients and surgically induced astigmatism which depends on the size, site and configuration of the surgical incision. The aim is to achieve a good refractive outcome postoperatively with minimal postoperative corneal astigmatism and quality vision without spectacle dependency.
- According to Nielsen P et al,[7] a 3.2 mm clear corneal incision results in SIA of 0.5 D.
- Devgan et al[12], suggests a typical temporal incision induces 0.5 D of flattening at that meridian where as superior incision causes upto 1 D of flattening at that meridian.
- The present study included 84 eyes of 84 patients with uncomplicated immature cataract and Pre existing corneal astigmatism upto 1.5 D.
- All the patients underwent 3.2 mm clear corneal incision phacoemulsification surgery. Depending upon the type of corneal PEA i.e ATR or WTR, patients were divided into two groups superior incision and temporal incision group. Patients with WTR underwent superior incision phacoemulsification whereas patients with ATR underwent temporal incision phacoemulsification. Each group included 42 patients.
- There was no statistically significant difference between the two groups with respect to age , gender, operated eye and and grade of cataract.
- Postoperatively UCVA at 6 weeks in superior incision group majority of patients 28(66.67%) attained visual acuity in the range of 6/9 – 6/6 out of which 4 patients had UCVA of 6/6. There was statistically significant difference (P value was 0.0001) between preoperative and postoperative UCVA in superior incision group. Suggestive of better postoperative UCVA.
- Postoperatively UCVA in temporal incision group majority of patients 27(64.29%) attained visual acuity in the range of 6/9 – 6/6, out which 4 patients gained UCVA of 6/6. There was statistically significant difference (P value was 0.0001) between preoperative and postoperative UCVA in temporal incision group. Suggestive of better postoperative UCVA.
- Harakuni et al[8], also studied the effect of clear corneal incision on steep meridian in eyes with PEA. In their study 95% of patients had visual acuity in the range of 6/12 – 6/6. Similar results are seen in our study. 73(87%) have attained visual acuity in the range of 6/12 – 6/6.
- In our study, superior incision group had preoperative corneal astigmatism of ≤0.5 D in 12(28.57%), 0.5 to 1 D in 26(61.90%) and 1 to 1.5 D in 4(9.52%) patients. Postoperatively, majority of patients had decrease in corneal astigmatism. 26(61.90%) had astigmatism of ≤0.5 D , followed by 10(23.81%) had 0.5 to 1 D, 4(9.52%) had 1 to 1.5 D and 2(4.76%) had 0 D i.e no astigmatism.

- Mean preoperative astigmatism in superior incision group was 0.78±0.35 and mean postoperative astigmatism was 0.48±0.35 P value was 0.02, there was statistically significant difference between preoperative and postoperative corneal astigmatism.

Thus there was reduction in corneal astigmatism.

- In temporal incision group, preoperative corneal astigmatism were 16(38.10%) had ≤0.5 D, 24(57.14%) had 0.5 to 1 D and 2(4.76%)had 1 to 1.5 D. Postoperatively, majority of patients had corneal astigmatism of ≤0.5 D in 22(52.38%), followed by 13(30.95%) had 0.5 to 1 D, 3(7.14%) had 1 to 1.5 D and 4(9.52%) had 0 D i.e no astigmatism.
- Mean preoperative astigmatism in temporal incision group was0.76 ± 0.28 and mean postoperative astigmatism was 0.45 ± 0.28. P value was 0.03, there was statistically significant difference between preoperative and postoperative corneal astigmatism. Thus there was reduction in corneal astigmatism.
- Similar result of reduction in corneal astigmatism by placing clear corneal incision on steep meridian in eyes with corneal PEA was seen in Harakuni et al, Akbar et al, Sangeeta et al and Abdul et al studies.[1,2,8,13] Thus our study results are consistent with the above studies.
- In our study SIA in superior incision group was, ≤0.5 D in 7(16.67%), 0.5 to 1D in 31(73.81%) and 1 to 1.5 D in 4(9.52%)patients.
- In temporal incision group SIA was, ≤0.5 D in 18(42.86%), 0.5 to 1 D in 22(52.38%) and 1 to 1.5 D in 2(4.76%) patients.
- The mean SIA in superior incision group was 0.68±0.22 D and in temporal was 0.55±0.20 D. P value was 0.029. There was statistically significant difference between SIA induced bysuperior and temporal incision suggestive of less SIA by temporal incision than superior incision.
- Harakuni et al[8], also studied the SIA in superior and temporal incision. In their study, the mean SIA in superior incision was 0.84±0.49 D and 0.70±0.35 D in temporal incision.
- They also suggested that temporal incision has less SIA than superior incision, however it wasn't statistically significant. Thus our results are consistent with the above study.
- The result our study indicates that, placing a clear corneal incision on steep meridian in eyes with corneal PEA of upto 1.5 D is usually sufficient to decrease or correct the corneal astigmatic error and also lessen the SIA. However it may not fully correct the astigmatic error. On comparing the SIA between the two incision site, temporal incision has less SIA than superior incision.

V. Limitations

The potential limitations of our study were :

1) It was hospital based which is located in central india. Therefore our study population do not represent india population as whole.
2) Small sample size.
3) Follow up period in our study was small.
4) We excluded the oblique astigmatism cases, which do exists and should also be considered.

VI. Conclusion

- In our study by placing incision in steep meridian there was significant reduction of corneal astigmatism postoperatively in majority of patients and hence better UCVA and less dependency on spectacles.
- The SIA by superior and temporal incision showed that temporal incision has less SIA than superior incision.
- Thus manipulation of incision, is a simple & effective technique to correct mild to moderate astigmatism, without any additional investment of time& instruments.
- By targeting both the spherical & cylindrical component of refraction, today's cataract surgeon aims to meet individual patient refractive goal.
- However placing incision on steep meridian alone may not fully correct the corneal astigmatism. The residual astigmatism can be corrected by other surgical procedure or can be corrected by spectacles.

VII. Recommendations

1) PEA & SIA should be taken into consideration pre operatively, to improve post operative visual outcome after phacoemulsification. Recommend to place incision on steep meridian in eyes with mild to moderate astigmatism.
2) A study with long term follow up period can be conducted so as to study the stability or regression of the astigmatic outcome.

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Abbreviations

PEA = Pre existing astigmatism
IOL= Intraocular lens
D = Dioptres
ATR= Against the rue astigmatism
NS = Nuclear sclerosis
SIA= Surgically induced astigmatism
UCVA= Uncorrected visual acuity
LOCS= Lens opacities classification system
WTR= With the rule astigmatism
PSC = Posterior subcapsular cataract.

Dr. Archana Thool. "Outcome of Clear Corneal Incision on Steep Meridian in Eye with Pre Existing Corneal Astigmatism after Phacoemulsification."." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 17, no. 11, 2018, pp 11-18.