Original research article

COMPARISON OF ASTIGMATIC OUTCOMES AFTER PHACOEMULSIFICATION WITH SUPERIOR, TEMPORAL OR OBLIQUE CLEAR CORNEAL INCISIONS: A RANDOMIZED PROSPECTIVE TRIAL

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Abstract

Introduction: A variety of modalities are available presently to deal with astigmatism in relation to phacoemulsification surgery. Of these, toric intraocular lenses are expensive, limbal relaxing incisions are unpredictable and both of these cater to a limited dioptric range and type of astigmatism. Simply planning the incision according to pre-existing corneal astigmatism is an economical and rationale way of addressing this issue. To compare residual post operative astigmatism after phacoemulsification with foldable IOL's implantation with different sites of clear corneal incision in patients with pre-existing astigmatism.

Material and Methods: Study was done to evaluate residual corneal astigmatism after phacoemulsification with foldable intraocular lens implantation from Jan 13 to May14. A total of 90 eyes of 85 patients were selected having visually significant cataract. Incision was planned on steeper axis on basis of preoperative keratometric values and divided into 3 groups namely, WTR who received superior clear corneal incision (CCI), ATR who received temporal and OBQ received superotemporal or superonasal CCI respectively. Surgically induced astigmatism (SIA) was also calculated by SIA calculator using vector method. Statistical analysis used is Kruskal Wallis test, Chi-square test, F-test.

Results: Residual corneal astigmatism among the three groups was found to be non-significant. Comparison of mean preoperative and postoperative corneal astigmatism between 3 groups came out be statistically significant.

Conclusion: Study concludes that preoperative astigmatism should always be assessed and addressed peroperatively by suitable incision sites to provide best results.

Keywords: Astigmatism, Phacoemulsification, Surgically induced astigmatism

INTRODUCTION

Good quality of vision is one of the most prized possessions of human life. Cataract is a public health issue as it is a major cause of curable blindness. As there is no effective medical management, surgery is the only successful modality of treatment in such patients. Attainment of minimal postoperative astigmatism, rapid visual rehabilitation and best uncorrected visual acuity (UCVA) possible are the aims of modern cataract surgery.[1] Over the years cataract surgery is undergoing continuous refinements. But the postoperative astigmatism is still the major problem after cataract surgery. The main task of the ophthalmologist now, therefore, is to minimize it.

In our present study we compare residual post operative corneal astigmatism after phacoemulsification with foldable intraocular lens implantation with different sites of incision in patients with pre-existing astigmatism, thereby evaluating the effect of incision location and the SIA on counteracting the pre-existing corneal curvature astigmatism.

MATERIAL AND METHODS

A prospective randomized study to evaluate residual corneal astigmatism after phacoemulsification surgery with foldable intraocular lens implantation was carried out from January 2013 to May 2014. A total of 90 eyes of 85 patients with visually significant cataract for phacoemulsification with foldable Intra Ocular Lens (IOLs) were selected in the study period mentioned above. Patients of either sex in different age groups, having different grades of cataract, having pre operative corneal astigmatism of more than 0.5-2.0D on keratometry and with no evident retinal / corneal pathology were included in this study.

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Patients having corneal opacity, scarring, pterygium, keratoconus, keratoglobus, uveitis, pre-existing filtering bleb, uncontrollable diabetes mellitus, previous history of refractive surgery, intraoperatively converted to Small in Incision Cataract Surgery (SICS) or conventional Extracapsular Cataract Extraction (ECCE), posterior capsular rent during surgery, IOL or either haptic placed on the sulcus, post operatively wound gape, leak, dehiscence, iris prolapse, refractive surprise in form of spherical power 2-4 weeks after surgery, lost to follow up within 4-6 weeks of surgery were excluded from the study.

Preoperatively, meticulous history, visual acuity testing with Snellen's Test types**,** evaluation of anterior segment using slit lamp and detailed fundus examination was performed wherever possible under full mydriasis by direct and indirect ophthalmoscope. Retinoscopy was done using a streak retinoscope, preoperative keratometry was performed on all patients using a Bausch & Lomb type keratometer to determine the corneal component of astigmatism. This was done for calculation of IOL power by ultrasound A-scan method. No other method for corneal topography was done.

Preoperative corneal astigmatism was analysed as spherical (NIL),WTR (With-the-rule) having steeper axis between 61 and 120 degrees,ATR (Against-the-rule) with steeper axis between 0 to 30 and 150 to 180 degrees and oblique having steeper axis between 31 to 60 and 121 to 150 degrees. Astigmatism at post operative 6th week was considered as residual corneal astigmatism.SIA was calculated on basis of this and pre operative keratometric values by using SIA calculator using vector method. All calculations of cylindrical power were considered for convex (plus) cylinders as per the software used for calculating SIA.

All operations were performed by the same surgeon. The cornea was marked with a marker pen at 12'o clock position before giving anaesthesia to the patient in sitting position while instructing the patient to look straight ahead. All patients underwent phacoemulsification after peribulbar or topical anaesthesia where required. Clear corneal incision of uniform size of 2.8 mm was made with the help of disposable keratome. Incisions were planned on steeper axis on basis of preoperative keratometric readings and the patients were divided into 3 groups. Nasal incisions were not done owing to technical difficulty and surgeon non-preference. Group A comprised of patients who had WTR on presentation which means that the steep axis on keratometry falls on the vertical meridian between 61-120 degrees and these patients were operated through a superior clear corneal incision (CCI), Group B were those who had ATR which means that the steep axis on keratometry falls on the horizontal meridian between 0-30 and 150-180 degrees and were given temporal CCI during surgery and Group C had oblique astigmatism which means that the steep axis on keratometry falls between 31-60 and 121-150 degrees and operated through superotemporal or superonasal CCI.

Postoperative keratometry was performed on all patients at 2nd and 6th week follow-up respectively. Post-operative evaluation was carried out on 2nd and 6th week follow up visits. Patients were examined on slit lamp for wound integrity, evidence of inflammation, centration of lens etc. Each evaluation included uncorrected visual acuity (VA) for distance and keratometry. Patients received topical antibiotics and steroid combination (ofloxacin 0.3% and prednisolone acetate 1%) 8 times a day for 1 week and then tapering dose till further 1 month postoperatively along with systemic antibiotic e.g. ciprofloxacin 500 mg 2 times a day for 5 days. SIA was calculated on 6th week by software named SIA calculator version 1.0 which used vector analysis for calculation. All data was then collected and analyzed using appropriate statistical test. This study was undertaken with clearance from the Ethical Committee of the institute. Subjects were enrolled with an oral consent.

RESULTS

The data was analysed by Statistical Software SPSS version 20. The descriptive statistics were calculated for all ages and either sex across the three groups. Due to abnormality of astigmatism we applied Kruskal Wallis test to compare the astigmatism distribution among the three groups. Majority of patients fell in the 41-60 years age group range. Males out numbered females in all groups (59% were males against 41% female patients).

Mean preoperative corneal astigmatism was 0.76+/-0.3D in group WTR whereas it was equal in group ATR and OBQ i.e. 0.86D. There is no significant difference in the mean astigmatism (P=0.318) between different groups (WTR, ATR, and OBQ) (Table-1).

Table-1: Comparison of Pre-Operative Corneal Astigmatism Among The Three Groups.

Group	Mean (SD)	P-value
WTR	0.74 (0.30)	P=.0.318 (NS)
ATR	0.86 (0.40)	
OBQ	0.86 (0.33)	

*WTR-With the rule, ATR-Against the rule, OBQ-Oblique, SD-Standard deviation

Preoperative visual acuity was less than 3/60 in majority of patients (42.2%) among all the three groups and only 2.2% had vision of 6/18 or better. Out of total 90 patients 36 were in WTR group followed by 29 in ATR group and 25 in OBQ group (Table-2).

Table-2: Pre-Operative Visual Acuity Across The Three Groups

Range of VA	WTR (%)	ATR (%)	OBQ (%)	Total (%)
<3/60	18 (50.0)	10 (34.5)	10 (40.0)	38 (42.2)
3/60 to 5/60	7 (19.4)	4 (13.8)	9 (36.0)	20 (22.2)
6/60 to 6/24	10 (27.8)	14 (48.3)	6 (24.0)	30 (33.3)
>=6/18	1 (2.8)	1 (3.4)	-	2 (2.2)
Total	36	29	25	90

*VA-Visual acuity, WTR-With the rule, ATR-Against the rule, OBQ-Oblique, SD-Standard deviation

Mean post operative astigmatism at 6 weeks was 0.52+/-0.3D in WTR group while 0.45+/-0.23D was observed in group ATR. In OBQ group it was 0.43+/-0.17D. There is no significant difference (P=0.502) in the mean post operative corneal astigmatism between different groups (WTR, ATR and OBQ) (Table-3).

Table 3: Post –Operative Astigmatism at Six Weeks

Group	Mean (SD)	P-value
WTR	0.52 (0.32)	P=0.502
ATR	0.45 (0.23)	
OBQ	0.43 (0.17)	

*WTR-With the rule, ATR-Against the rule, OBQ-Oblique, SD-Standard deviation

Post operative astigmatism at 2nd and 6th week is lesser than the preoperative values in all the three groups and this difference came out to be significant as calculated by F-test (P<0.001). There is no significant difference is seen in mean surgically induced astigmatism among different incision groups. However mean SIA was less in WTR group where superior clear corneal incision was given as compared to other two groups (Table-4).

Table 4: Mean Surgically Induced Astigmatism

Group	Mean (SD)	P-value
WTR	0.97 (0.50)	P=0.872
ATR	1.036 (0.51)	
OBQ	1.01 (0.40)	

*WTR-With the rule, ATR-Against the rule, OBQ-Oblique, SD-Standard deviation

Two weeks postoperatively, in group WTR majority of patients i.e.72.2% had vision in range of 6/12-6/18, in group ATR 51.7% against the rule in group OBQ 84% of patients which had vision in range of 6/12-6/18 respectively and it was found to be non significant on applying chi-square test. (P=0.200).At 6th week follow-up, majority of patients (61.1%) in group WTR had vision in range of 6/6-6/9,in group ATR 89.7% of patients and in group OBQ 68% patients had visual acuity in range of 6/6-6/9 respectively and it was found to be significant (P=0.033) (Table-5 & Fig-1).

Table 5: Comparison of post operative visual acuity

Range of VA	After 2 weeks			After 6 weeks		
	WTR (%)	ATR (%)	OBQ (%)	WTR (%)	ATR (%)	OBQ (%)
6/6-6/9	10 (27.8)	11 (48.3)	4 (16.0)	22 (61.1)	26 (89.7)	17 (68.0)
6/12-6/18	26 (72.2)	18 (51.7)	21 (84.0)	14 (38.9)	3 (10.3)	8 (32.0)
Total	36	29	25	36	29	25
Chi-square test	**P=0.200 (not Significant)**			**P=0.033(Significant)**		

*VA-Visual acuity, WTR-With the rule, ATR-Against the rule, OBQ-Oblique, SD-Standard deviation

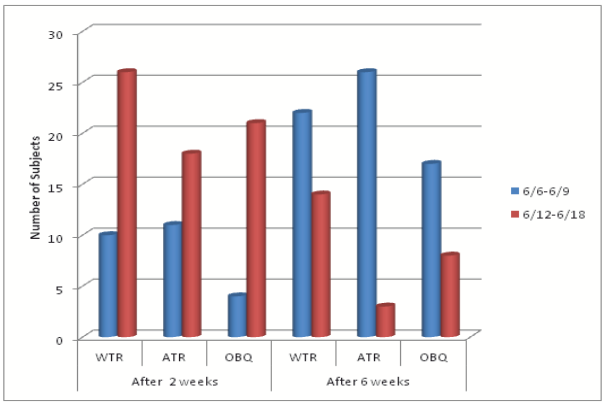

Figure-1: Histogram showing comparison of postoperative visual acuity

36 patients had preoperative astigmatism in range of 0.25-0.50D.At 6th week postoperatively 29 out of these 36 patients had astigmatism in same range while 9 patients had increased astigmatism in range of 0.75-1.00D.Preoperative astigmatism in range of 1.25-1.50D was seen in 9 patients which reduced to 0.25-0.50D at 6 weeks after surgery. Similarly, 3 patients had astigmatism of 1.75-2.00D before surgery which reduced to 0.25-0.50D in 1 patient and 0.75-1.00D in another 1 patient and 1 had similar value as it was preoperatively. Thus we observed a significant change in astigmatism level at 6 weeks after surgery from the pre-operative levels (Table-6).

Table-6: Comparison of Mean Pre-Operative and Post-Operative Corneal Astigmatism

	WTR Mean (SD)	ATR Mean (SD)	OBQ Mean (SD)	P-value
Pre-op Astigmatism				
	0.74 (0.31)	0.86 (0.40)	0.86 (0.33)	0.318
Post-op astigmatism				
2nd week	0.40 (0.17)	0.46 (0.23)	0.47 (0.23)	0.446
6th week	0.52 (0.32)	0.45 (0.23)	0.43 (0.17)	0.502
F-test				
(One factor Repeated measures ANOVA)	F=24.062 P<0.001	F=22.682 P<0.001	F=20.24 P<0.001	
Pre vs. Post (2 weeks)	0.000 P<0.001	0.000 P<0.001	0.000 P<0.001	
Pre vs. Post (6 weeks)	0.000 P<0.001	0.000 P<0.001	0.000 P<0.001	

*WTR-With rule, ATR-Against the rule, OBQ-Oblique, SD-Standard deviation

DISCUSSION

Majority of patients were in range of 41-60 years. Study conducted by Rodica et al[2] supports fewer cases of cataract above 80 years of age, as is one of the findings observed in this study as well. Similar to this study, Chavan P.P. et al[3] in their study had 319 males and 243 females with majority of patients in 61-70 years of age group. Yongqi He et al[4] in their work observed 50 male and 70 female patients with age varied between 25 to 70 years contrary to our study.

In present study, mean preoperative corneal astigmatism was 0.76+/-0.3D in group WTR whereas it was equal in group ATR and OBQ i.e. 0.86D. No significant difference was observed in the mean preoperative astigmatism between the different groups (WTR, ATR and OBQ). Similarly, Chavan P.P. et al[3] in a comparative study of sub 3 mm and 5.25 mm incisions in patients undergoing cataract surgery with respect to post operative visual acuity and refractive errors, observed that mean preoperative astigmatism in two groups was statistically not significant.

Pre-operative visual acuity was less than 3/60 in 18 patients (50%) in WTR Group in our study. In group ATR majority of patients had visual acuity in range of 6/60-6/24 i.e. 14 patients (48.3%).Majority of patients were having less than 3/60 preoperative vision in group OBQ i.e. 10 patients (40%). Emris et al[1] in their study on SIA after superotemporal and superonasal clear corneal incisions in phacoemulsification concluded that no statistical difference was seen in preoperative visual acuity among the incision groups.

Post operative astigmatism after cataract surgery is of ATR type, which is caused by flattening of the meridian at right angles to the direction of the incision. In this study, mean post operative astigmatism at 6 weeks was considered as residual corneal astigmatism and it was 0.52+/-0.3D in WTR group while 0.45+/-0.23D was observed in group ATR. In OBQ group it was 0.43+/-0.17D and no significant difference was seen among these groups. Post operative corneal astigmatism reduced by 6th week as compared to preoperative astigmatism.

Simsek S et al.[5] evaluated the effect of superior and temporal clear corneal incisions on astigmatism after phacoemulsification in 40 eyes of 20 patients. Temporal incision group showed significantly lower astigmatism. Upper lid pressure on the superior corneal incisions led to fluctuating against the rule astigmatism that was significantly higher than that induced by temporal incisions.

Irina S Barequet et al.[6] conducted a study in 178 eyes with temporal clear corneal incision in right eye and nasal incision in left eye after phacoemulsification and compared short and long term astigmatism outcome. They found that cataract surgery using a horizontal clear corneal incision induced WTR astigmatism and temporal incision induced significantly less astigmatism than nasal incisions[6]. In present study incision was given on the steep meridian which was determined preoperatively, leading to decreased postoperative astigmatism. Similar results were observed by Rho CR et al[7] and evaluated that phacoemulsification performed by a single surgeon using same incision style and size and marking corneal incision on preoperative steep meridian and found significantly decreased post operative keratometric readings in the temporal, superotemporal and superior locations. It is desirable to locate the corneal incision on the steep meridian in eyes with corneal astigmatism more than 0.5D.

A comparison between mean preoperative and postoperative corneal astigmatism at 2nd and 6th week was observed. In group WTR when superior clear corneal incision was performed, mean preoperative astigmatism of 0.74+/-0.31D was reduced to 0.40+/-0.17D postoperatively at 2nd week and then increased to 0.52+/-0.32D after 6 weeks of surgery. When temporal incisions were given in ATR group post operative astigmatism at 2nd week was 0.46+/-0.23D and at 6th week it was 0.45+/-0.23D which reduced from 0.86+/-0.40D preoperatively. On applying oblique incision i.e. superotemporal or superonasal, mean preoperative astigmatism of 0.86+/-

0.33D reduced to 0.47+/-0.23D at 2nd week after surgery and further reduced to 0.43+/-0.17D at postoperative 6th week. On statistical analysis, this difference in pre and post operative astigmatism at 2nd and 6th week was found to be statistically significant (P<0.001) for each group on applying an appropriate statistical test.

Akbar Khan et al[8] did a study on effect of incision site on pre-existing astigmatism in phacoemulsification and on comparing preoperative and postoperative astigmatism, a statistically significant difference was observed.Contrary to this study, Sanja Masnec-Pakvalin et al[9] in their research on comparison of preoperative and postoperative astigmatism after superotemporal or superonasal clear corneal incision in phacoemulsification observed that there was no statistically significant difference between preoperative and postoperative astigmatism.

Mean SIA was compared among three groups and analysis was done according to the location of incision. No statistically significant difference however, seen in mean SIA among different groups. Similar to this study, where mean SIA at 6th week in superior, temporal, superotemporal or superonasal incisions was non-significant. Yoon JH et al[10] compared SIA after 3 mm temporal and nasal clear corneal incisions in bilateral cataract surgery and concluded that SIA at postoperative 1 and 3 month in temporal and nasal incisions was not significant.

Post operative visual acuity analysis was done at 2nd and 6th week respectively. At 2nd week follow up, majority of patients among three groups had visual acuity in range of 6/12-6/18 and it was found to be non-significant. Visual acuity improved to 6/6-6/9 at 6th week follow up in majority of patients among three groups and this improvement was found to be statistically significant (P=0.033). Brian JJ et al[11] conducted a study to determine the astigmatic effect of an oblique clear corneal phacoemulsification. They concluded that decreased astigmatism with superotemporal incision leads to better visual rehabilitation and visual function.

Similar to present study, Yoon JH et al[10] concluded in their study that UCVA in temporal and nasal incision groups at 1 and 3 month was higher than that before surgery. But UCVA was similar between temporal and nasal incision groups post-operatively.

Pre and post operative astigmatism cross tabulation was done which showed that preoperative astigmatism in range of 1.25-1.50D was seen in 9 patients which reduced to 0.25-0.50D at 6 weeks after surgery. This reduction of astigmatism from preoperative values seen after 6th week of surgery was significant on applying a statistical test and showed that reduction in post operative astigmatism depends on large preoperative astigmatism.

A study conducted by Ninn Pedersen K proved that the most important predisposing factor for rapid changes in the postoperative astigmatism were large preoperative astigmatism, young age and preoperative intraocular pressure.[12]

Another study by Anders N, et al. confirmed that age and preoperative astigmatism were found to influence induced astigmatism significantly.[13]

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