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Research Article

Efficacy and Safety of Opposite Clear Corneal Incision to Reduce Pre-existing Astigmatism After Phacoemulsification - A Prospective Study

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Abstract

Design: This was a comparative, prospective, randomized study.

Setting: Department of Ophthalmology, Government Medical College, Patiala, Punjab.

Purpose: To compare the efficacy and safety of Opposite Clear Corneal Incision to reduce pre-existing astigmatism after phacoemulsification in tertiary Eye Care centre of India.

In this prospective, comparative study 160 patients planned for phacoemulsification were divided into 2 groups. Group A received a foldable IOL through 3.2 mm clear corneal incision made on the steeper meridian along with a 3.2 mm opposite clear corneal incision in an attempt to reduce pre-existing astigmatism. Group B received a foldable IOL through a single clear corneal incision made on the steeper meridian. The preoperative and postoperative data at day 7, 1 month, 3 months and 6 months, on UCVA, BCVA, astigmatism was compared between the groups.

Results: A total of 160 patients were enrolled in the study. These patients were divided into 2 groups with 80 patients in each group. The mean preoperative astigmatism was 1.40 +/- 0.31 in group A which reduced to 0.61 +/- 0.14 D after 6 months. The mean preoperative astigmatism was 1.34 +/- 0.26 D in group B, which reduced to 0.98 +/- 0.18 D after 6 months of follow up. The average mean astigmatic reduction in group A and B was 0.79 D and 0.30 D respectively. There was a significant difference in mean astigmatism between both the groups after 6 months of follow up (p Value < 0.05). 95% of patients had uncorrected visual acuity between 6/6 - 6/9 in group A whereas 55% patients had UCVA between 6/6 - 6/9 after 6 months (p Value < 0.05). None of the patients had UCVA less than 6/18 in both groups. The BCVA was between 6/6 - 6/9 in 97.5% and 95% of patients in group A and group B respectively, which showed no significant difference in terms of BCVA.

Conclusion: Being an advancement in refractive lenticular surgery, Opposite Clear Corneal Incision is a safe and cost effective procedure in reducing mild to moderate preexisting corneal astigmatism if reliable preoperative corneal topography readings using pentacam are available. They may be employed during phacoemulsification surgery to further enhance visual outcomes and patient satisfaction.

Keywords: Cataract; Phacoemulsification; Opposite Clear Corneal Incision (OCCI); Clear Corneal Incision (CCI); Astigmatism; Visual Acuity

Introduction

Cataract is one of the most common causes of visual impairment in the world. According to the World Health Organization (WHO), cataract is the leading cause of blindness all over the world accounting for 17.7 million blind people [1]. The outcome of cataract surgery for an individual or a defined population is as important as measuring the quantity of surgical operations performed [2]. For over a century, it has been recognized that cataract incisions influence astigmatism. In past few years, however, the surgeons have mounted serious investigations aimed at measuring and minimizing astigmatism during cataract surgery [3].

Foldable IOL implantation has resulted in reducing the problem of postoperative astigmatism very efficiently [4]. As astigmatism can cause blurring of vision, asthenopia, glare sensation, monocular diplopia, not correcting the astigmatic component at the time of cataract surgery will thus fail to achieve spectacle independence as well as quality of life. Today's refractive cataract surgeons determine the starting point (pre-existing astigmatism), know the astigmatic effect of various approaches and select a surgical plan that optimizes the refractive outcome [5]. The presence of pre-existing astigmatism (PEA) affects visual acuity and quality of vision after the cataract surgery. Various methods have been employed for reducing the astigmatism [6]. These have included: changing the size and location of incisions, limbal relaxing incisions, opposite clear corneal incisions at the steep meridian [7], applying toric intraocular lenses, excimer lasers, and LASIK [8].

All these mentioned procedures have their own disadvantages, such as the absence of the excimer laser in many surgical centers, the high cost of toric intraocular lenses and their probability of rotation after surgery, and the requirement of expensive diamond knives in relaxing incisions [9]. Constructing the incision on the steeper meridian during the cataract surgery is one of the simplest methods to correct pre-operatively existing astigmatism [10]. Opposite clear corneal incision (OCCI) is another simpler technique that requires no extra instrumentation and expertise. It has better neutralizing effect on astigmatism than single clear corneal incision according to various studies [11-13].

The present study was conducted to compare the effect of opposite clear corneal incision of 3.2 mm given on the steeper meridian to reduce the pre existing astigmatism vs a single 3.2 mm clear corneal incision given for phacoemulsification.

Material and Methods

The comparative study was conducted on 160 patients (80 patients in group A which comprised of patients who had undergone phacoemulsification along with OCCI and 80 patients in group B which included patients with single Clear Corneal Incision (CCI) aged between 40-80 years diagnosed with cataract and pre operative astigmatism > 1D, attending Outdoor Patient Department in Govt. Medical College, Patiala. A written and informed consent was taken from the patients in accordance with declaration of Helsinki. All the patients were given an option to opt out of the study at any point of time without having to furnish any reason for doing so. The inherent risk associated with an extra incision was elaborately explained to all the patients enrolled in the study.

Inclusion criteria included both males and females of age group 40-80 years, with cataract and preoperative Corneal astigmatism > 1 D measured using Corneal topography (Pentacam).

Exclusion criteria included patients who had any corneal pathology such as corneal stromal scarring, corneal degenerations or dystrophies, pterygium or irregular astigmatism etc., intraocular pressure > 21 mm Hg or glaucomatous optic atrophy, diabetic retinopathy or hypertensive retinopathy or other fundus retinal pathology, complicated cataract, traumatic cataract, subluxation of lens.

History

A detailed history was taken including gender, age at presentation, health, use of medication. Specifically, patients were questioned regarding history of any chronic disease as hypertension, diabetes mellitus. Any history of ocular trauma or prior ocular surgery was also taken.

Ocular examination

Complete preoperative ocular examination was done including uncorrected visual acuity, best corrected visual acuity, IOP measurement, pentacam based analysis of astigmatism, slit lamp biomicroscopy and detailed fundus examination.

- **Group A**: Comprised of 80 patients who underwent phacoemulsification with implantation of foldable IOL through a 3.2 mm clear corneal incision on the steeper meridian. An opposite clear corneal incision (OCCI) of 3.2 mm was given on the steeper meridian in an attempt to reduce pre existing astigmatism.
- **Group B:** Comprised of 80 patients who underwent phacoemulsification with implantation of foldable IOL

through a 3.2 mm clear corneal incision on the steeper meridian. No OCCI was given in this group.

Pentacam

Pentacam imaging was done with patient focusing directly at the centre of fixation target. Scheimpflug camera automatically captured 25 single images within 2 seconds for the study eye. From the pentacam examination, flat (K1) and steep (K2) keratometric readings and astigmatism were recorded. Readings were taken from Holladay report-1 Equivalent K Reading (EKR) with 4.5mm pupil diameter. Pre-operative pentacam based keratometric readings were taken. Post operative follow up was done at day 1, day 7, 1 month, 3 months and 6 months.

Techniques of Surgery

Patient was made to lie on the operating table and betadine painting and draping of eye was done. Peribulbar anaesthesia was given in the eye to be operated upon. The patient was protected by a sterile field but could breathe and speak normally. Two side ports were made with 15-degree lancet tip blade. A thick, dispersive viscoelastic was injected into the anterior chamber to provide a working space and protect the inner surface (endothelial layer) of the cornea. A clear corneal incision of 3.2 mm (typically a tri-planar wound to promote self-seal) was created on the steeper meridian wherever it was with a keratome. A continuous curvilinear capsulorhexis of approximately 5-5.5 mm diameter was made after staining the capsule with trypan blue dye, using a cystotome or a rhexis forceps. Most of the capsule was left intact to provide a pouch for insertion of the IOL. This was a very important surgical step since mistakes could have made the removal of the natural lens and intraocular lens (IOL) insertion very difficult. The cortex was separated from the underlying capsule by injecting a balanced salt solution (BSS) between the cortex and capsule (hydrodissection). The surgeon spinned or rotated the lens to ensure it was freely mobile. Hydrodelienation was similarly performed to separate the endonucleus from the epinucleus in required cases. A phacoemulsification probe used ultrasonic energy to break up the lens nucleus. A vacuum attached to the same probe removed the nucleus fragments that were generated. Several approaches were used, including a “divide and conquer” approach whereby the nucleus was first divided into four main pieces. The cortex was aspirated and pulled away from the capsule. Care was taken to avoid tearing the capsule and allowing vitreous leakage into the anterior chamber. The capsular bag was filled with a cohesive OVD thus creating a space to inject the lens into it. A hydrophilic foldable Intraocular lens (IOL) was then inserted into the capsular bag using a lens injector, where it uncurled automatically. The OVD was aspirated from the capsular bag and anterior chamber by doing I/A. In group A, an opposite clear corneal incision of 3.2 mm was made with a keratome while keeping irrigation canula still in the eye (Figure 1). This OCCI was not used for any further instrumentation or manipulation later on. In group B, this step was omitted. The corneal incision was hydrated with BSS, which caused local corneal epithelial cells to expand and compress each other and allowed for wound closure without sutures. Topical antibiotic eye drops and a topical steroid were instilled immediate postoperatively.

Postoperative Follow ups

Post operative follow ups were done at day 1, day 7, 1 month, 3 months and 6 months in both the groups. The patients were subjected to UCVA, BCVA, pentacam based analysis of astigmatism on each follow up visit.

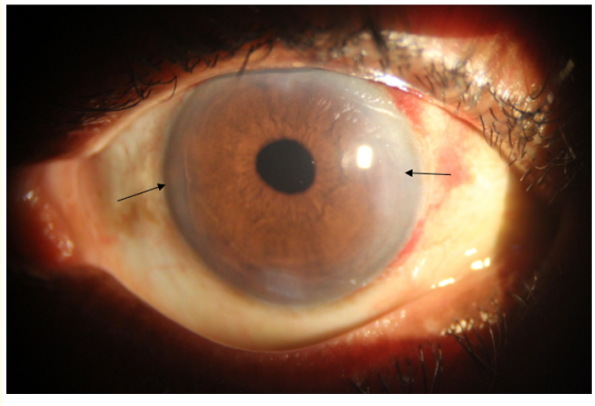


Figure 1: Temporal main wound with opposite clear corneal incision.

Statistical analysis

The data was collected from 160 patients divided into two groups with 80 patients in each group. The data was collected from the patients using case report form. The data was then entered in excel. The data obtained was statistically analyzed using SPSS version 20 (IBM, NY, USA). Chi-square test and t test (independent and dependent) were used for the assessment of level of significance. The p Value of < 0.05 was considered statistically significant.

Observations and Results

We performed a prospective, randomized controlled trial on 160 patients presented to the Department of Ophthalmology,

Government Medical College, Patiala. The randomization procedure included the use of random number tables. Only one investigator (SG) had the knowledge about the randomization whereas all the phacoemulsification procedures were carried out by other investigator (AA). Out of 160 patients, 80 patients were enrolled in group A in which paired clear corneal incision was given on the steeper meridian while performing phacoemulsification and 80 patients were allocated to group B, where only a single CCI was given on the steeper meridian while performing phacoemulsification.

In group A, 53.75% of patients belonged to age group of 61-70 years and in Group B, 51.25% of patients belonged to age group of 61-70 years (Table 1). The mean age of patients in group A was 64.83 +/- 8.93 and mean age of patients in group B was 65.07 +/- 8.61 years. There was no significant difference in both groups with respect to age wise distribution. 55% of patients in group A were males and rest were females and 57.5% of patients were males in group B while the rest were females (Table 2).

In group A, 31.25% of patients had UCVA between 6/24 - 6/36 preoperatively and 68.75% patients had UCVA < 6/60. At post operative day 7, 35% of patients had UCVA between 6/6 - 6/9 and 65% of patients had UCVA 6/12 - 6/18. At 1 month visit, 68.75% of patients had UCVA between 6/6 - 6/9 and 31.25% of patients had UCVA 6/12 - 6/18. At 3 month visit, 95% of patients had UCVA between 6/6 - 6/9 and 5% of patients had UCVA 6/12 - 6/18. Similarly, at 6 months postoperative visit, 95% of patients had UCVA between 6/6 - 6/9 and 5% of patients had UCVA 6/12 - 6/18.

In group B, 32.5% of patients had UCVA between 6/24 - 6/36 preoperatively and 67.5% patients had UCVA < 6/60. This showed that the randomisation procedure was effective in segregating patients with similar visual profile in the two groups. At post operative day 7, 27.5% of patients had UCVA between 6/6 - 6/9 and 72.5% of patients had UCVA 6/12 - 6/18. At 1 month visit, 40% of patients had UCVA between 6/6 - 6/9 and 60% of patients had UCVA 6/12 - 6/18. At 3 month visit, 53.75% of patients had UCVA between 6/6 - 6/9 and 46.25% of patients had UCVA 6/12 - 6/18. Similarly, at 6 months postoperative visit, 55% of patients had UCVA between 6/6 - 6/9 and 45% of patients had UCVA 6/12 - 6/18. The difference in UCVA was significant at 1 month, 3 months and 6 months postoperative visits in both the groups (p Value <0.05). Patients in group A had better uncorrected visual acuity on postoperative follow ups as compared to group B (Table 3 and 4).

In group A, 12.5% patients had preoperative BCVA between 6/12 - 6/18, 46.25% patients had preoperative BCVA between 6/24 - 6/36 and 41.25% patients had preoperative BCVA less than 6/60. 88.75% patients had BCVA between 6/6-6/9 and 11.25% patients had BCVA between 6/12-6/18 at postoperative Day 7. In group A, 96.25% patients had BCVA between 6/6 - 6/9 and 3.75% patients had BCVA between 6/12 - 6/18 at 1 month post operative visit. 97.5% patients had preoperative BCVA between 6/6 - 6/9, 2.5% patients had preoperative BCVA between 6/12 - 6/18 at 3 months postoperatively. Similarly, 97.5% patients had preoperative BCVA between 6/6 - 6/9, 2.5% patients had preoperative BCVA between 6/12 - 6/18 at 6 months postoperatively.

In group B, 11.25% patients had preoperative BCVA between 6/12 - 6/18, 46.25% patients had preoperative BCVA between 6/24 - 6/36 and 42.5% patients had preoperative BCVA less than 6/60. 87.5% patients had BCVA between 6/6-6/9 and 12.5% patients had BCVA between 6/12-6/18 at postoperative Day 7. In group B, 93.75% patients had BCVA between 6/6 - 6/9 and 6.25% patients had BCVA between 6/12 - 6/18 at 1 month post operative visit. 95% patients had preoperative BCVA between 6/6 - 6/9, 5% patients had preoperative BCVA between 6/12 - 6/18 at 3 months postoperatively. Similarly, 95% patients had preoperative BCVA between 6/6 - 6/9, 5% patients had preoperative BCVA between 6/12 - 6/18 at 6 months postoperatively. None of the patients belonging to either groups had BCVA less than 6/18 at the end of 6 months. There was no clinically significant difference between both groups in regard to BCVA (Table 5 and 6).

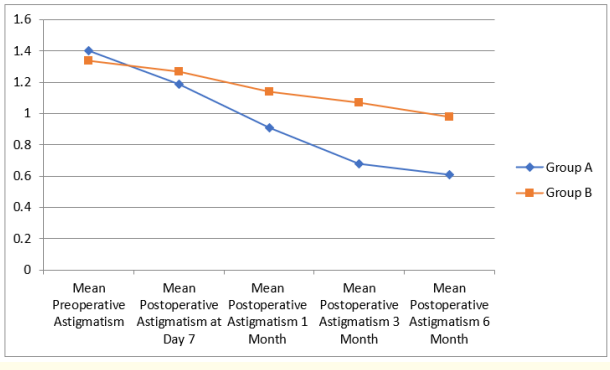
The mean preoperative astigmatism in group A was 1.40 +/- 0.31 D. The mean post operative astigmatic values at day 7, 1 month, 3 month and 6 month visits were 1.19 +/- 0.20, 0.91 +/- 0.18, 0.68 +/- 0.13 and 0.61 +/- 0.14 D respectively. The mean astigmatic correction at the end of 6 months in group A was 0.79 D. The preoperative mean astigmatic value was 1.34 +/- 0.26 D in group B. The mean astigmatism in group B at post operative day 7, 1 month, 3 months and 6 months follow up visit was 1.27 D +/- 0.23, 1.14 +/- 0.20 D, 1.07 +/- 0.18 D and 0.98 +/- 0.18 D respectively. Thus, the mean astigmatic correction at the 6 months in group B was 0.36 D. The difference in mean post operative astigmatism was significant between both the groups on postoperative 1 month, 3 months and 6 months visit (p Value < 0.05) (Table7, Graph 1 and 2).

The mean flat preoperative keratometric reading (K1) in group A was 44.17 +/- 1.26 D. The mean flat keratometric readings (K1) at postoperative day 7, 1 month, 3 months, 6 months follow up visits were 44.17 +/- 1.29 D, 44.16 +/- 1.27 D, 44.14 +/- 1.31 D, 44.13 +/- 1.31 D respectively in group A (Table 8). The mean steep

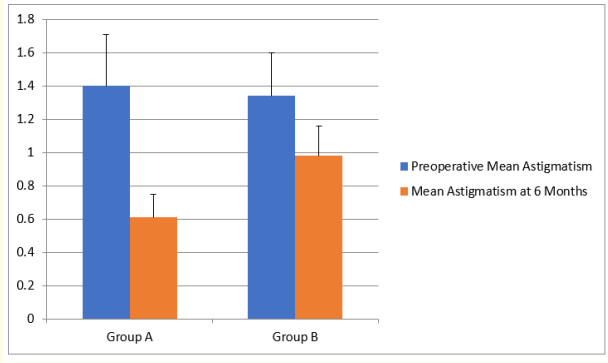
preoperative keratometric reading (K2) in group A was 45.57 +/- 1.17 D. The mean steep postoperative keratometric readings (K2) were 45.36 +/- 1.23 D, 44.99 +/- 1.68 D, 44.85 +/- 1.31 D and 44.78 +/- 1.31 D at day 7, 1 month, 3 months, 6 months follow up (Table 9).

The mean flat preoperative keratometric reading (K1) in group B was 43.42 +/- 1.60 D. The mean flat keratometric readings (K1) at postoperative day 7, 1 month, 3 months, 6 months follow up visits were 43.43 +/- 1.61 D, 43.44 +/- 1.63 D, 43.44 +/- 1.63 D, 43.45 +/- 1.63 D respectively in group A. The mean steep preoperative keratometric reading (K2) in group A was 44.76 +/- 1.57 D (Table 10). The mean steep postoperative keratometric readings (K2) were 44.70 +/- 1.59 D, 44.59 +/- 1.59 D, 44.49 +/- 1.62 D and 44.40 +/- 1.60 D at day 7, 1 month, 3 months, 6 months follow up (Table 11). There was no significant difference in the mean flat preoperative and postoperative K1 readings. The difference in mean steep keratometric readings (K2) was significant at each visit in both the groups when compared to their respective mean steep preoperative keratometric readings (K2) (p Value < 0.05).

Four patients in group A didn't show any change in their astigmatic error even with paired CCI after 6 months of follow up. One patient in Group A developed shallow anterior chamber on post operative day 1 which required resuturing, rest all had uneventful postoperative period.



Graph 1: Comparison between group A and Group B over a period of 6 months.



Graph 2: Average Mean Astigmatism Reduction in Group A and Group B after 6 months.

Age group (in years)	Group A (Foldable IOL with paired CCI)		Group B (Foldable IOL with single CCI)	
	Number of patients	Percentage	Number of patients	Percentage
40-50	8	10.0	7	8.75
51-60	12	15.0	14	17.5
61-70	43	53.75	41	51.25
71-80	17	21.25	18	22.5
Mean +/- SD; 64.83 +/- 8.93; 65.07 +/- 8.61 p-value = 0.961				

Table 1: Age Wise Distribution.
*p-value <0.05 is taken as significant.

Gender distribution	Group A (Foldable IOL with paired CCI)		Group B (Foldable IOL with single CCI)	
	Number of patients	Percentage	Number of patients	Percentage
Male	44	55.0	46	57.5
Female	36	44.0	34	42.5
Total	80	100	80	100
p Value = 0.750 Significance = NS				

Table 2: Gender Wise Distribution.

Uncorrected Visual Acuity	Preoperative		Day 7		1 month	
	Group A	Group B	Group A	Group B	Group A	Group B
6/6 - 6/9	0(0.0%)	0(0.0%)	28(35%)	22(27.5%)	55(68.75%)	32(40%)
6/12 - 6/18	0(0.0%)	0(0.0%)	52(65%)	58(72.5%)	25(31.25%)	48(60%)
6/24 - 6/36	25(31.25%)	26(32.5%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
< 6/60	55(68.75%)	54(67.5%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
p Value	0.865		0.306		<0.001	

Table 3: Visual outcomes (UCVA) in both group A and B after cataract surgery.

Uncorrected Visual Acuity	3 month		6 month	
	Group A	Group B	Group A	Group B
6/6 - 6/9	76(95%)	43(53.75%)	76(95%)	44(55%)
6/12 - 6/18	4(5.0%)	37(46.25%)	4(5.0%)	36(45%)
6/24 - 6/36	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
< 6/60	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
p Value	<0.001		<0.001	

Table 4: Visual outcomes (UCVA) in both group A and B after cataract surgery.

Best Corrected Visual Acuity	Preoperative		Day 7		1 month	
	Group A	Group B	Group A	Group B	Group A	Group B
6/6 - 6/9	0(0.0%)	0(0.0%)	71(88.75%)	70(87.5%)	77(96.25%)	75(93.75%)
6/12 - 6/18	10(12.5%)	9(11.25%)	9(11.25%)	10(12.5%)	3(3.75%)	5(6.25%)
6/24 - 6/36	37(46.25%)	37(46.25%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
< 6/60	33(41.25%)	34(42.5%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
p Value	0.967		0.807		0.468	

Table 5: Visual outcomes (BCVA) in both group A and B after cataract surgery.

Best corrected Visual Acuity	3 month		6 month	
	Group A	Group B	Group A	Group B
6/6 - 6/9	78(97.5%)	76(95%)	78(97.5%)	76(95%)
6/12 - 6/18	2(2.5%)	4(5.0%)	2(2.5%)	4(5.0%)
6/24 - 6/36	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
< 6/60	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
p Value	0.681		0.681	

Table 6: Visual outcomes (BCVA) in both group A and B after cataract surgery.

Mean Astigmatism	Group A (Foldable IOL with paired CCI)		Group B (Foldable IOL with single CCI)		p Value
	Mean (D)	SD	Mean (D)	SD	
Pre Operative	1.40	0.31	1.34	0.26	0.595
Day 7	1.19	0.20	1.27	0.23	0.015
1 Month	0.91	0.18	1.14	0.20	<0.001
3 Month	0.68	0.13	1.07	0.18	<0.001
6 Month	0.61	0.14	0.98	0.18	<0.001

Table 7: Comparison of Mean Astigmatism between OCCI and CCI groups (D=Diopters).

Mean flat keratometric reading (K1)	Group A (Foldable IOL with paired CCI)		
Preoperative 44.17 ± 1.26	Preoperative 44.17 ± 1.26	Preoperative 44.17 ± 1.26	Preoperative 44.17 ± 1.26
Postoperative day 7 44.14 ± 1.29	Postoperative 1 month 44.16 ± 1.27	Postoperative 3 months 44.14 ± 1.31	Postoperative 6 months 44.13 ± 1.31
p Value = 0.167	p Value = 0.600	p Value = 0.218	p Value = 0.139

Table 8: Comparison of mean flat preoperative keratometric readings (K1) with mean flat postoperative keratometric readings (K1) in group A (in dioptres).

Mean steep keratometric reading (K2)	Group A (Foldable IOL with paired CCI)		
Preoperative 45.57 ± 1.17	Preoperative 45.57 ± 1.17	Preoperative 45.57 ± 1.17	Preoperative 45.57 ± 1.17
Postoperative day 7 45.36 ± 1.23	Postoperative 1 month 44.99 ± 1.68	Postoperative 3 month 44.85 ± 1.31	Postoperative 6 month 44.78 ± 1.31
p Value = <0.001	p Value = <0.001	p Value = <0.001	p Value = <0.001

Table 9: Comparison of mean steep preoperative keratometric readings (K2) with mean steep postoperative keratometric readings (K2) in group A (in dioptres).

Mean flat keratometric reading (K1)	Group B (Foldable IOL with single CCI)		
Preoperative 43.42 ± 1.60	Preoperative 43.42 ± 1.60	Preoperative 43.42 ± 1.60	Preoperative 43.42 ± 1.60
Postoperative day 7 43.43 ± 1.61	Postoperative 1 month 43.44 ± 1.63	Postoperative 3 months 43.44 ± 1.63	Postoperative 6 months 43.45 ± 1.63
p Value = 0.801	p Value = 0.937	p Value = 0.937	p Value = 0.906

Table 10: Comparison of mean flat preoperative keratometric readings (K1) with mean flat postoperative keratometric readings (K1) in group B (in dioptres).

Mean steep keratometric reading (K2)	Group B (Foldable IOL with single CCI)		
Preoperative 44.76 ±1.57	Preoperative 44.76 ±1.57	Preoperative 44.76 ±1.57	Preoperative 44.76 ±1.57
Postoperative day 7 44.70 ± 1.59	Postoperative 1 month 44.59 ± 1.59	Postoperative 3 months 44.49 ±1.62	Postoperative 6 months 44.40 ± 1.60
p Value = <0.001	p Value = <0.001	p Value = <0.001	p Value = <0.001

Table 11: Comparison of mean steep preoperative keratometric readings (K2) with mean steep postoperative keratometric readings (K2) in group B (in dioptres).

Discussion

Astigmatism is a major cause patients' dis-satisfaction after cataract surgery. Thus, several techniques have been developed to manage preexisting astigmatism during cataract surgery, aiming to eliminate spectacle dependence. Preexisting corneal astigmatism at the time of cataract surgery can be treated by various methods which include manipulation of cataract incision, limbal relaxing incision, astigmatic keratotomy or implantation of toric intraocular lenses. The site, size and shape of cataract incision also influences the astigmatism [14].

Regarding the architecture of the cornea, giving phacoemulsification incision on the steepest corneal axis at the time of cataract surgery can correct a small amount of astigmatism [15]. Opposite clear corneal incision (OCCI) is a relatively simple technique requiring no extra instrumentation and can be done in routine settings, but may be difficult with certain axes. Lever and Dahan were the first ophthalmologists to introduce OCCI surgical technique in the year 2000. They found that a CCI has a small flattening effect on corneal curvature due to formation of scar tissue which can be used to reduce pre-existing astigmatism [16]. The amount of correction varies, but is usually reported to be less than 1.2D with single 3.2 mm incision in various studies.

In the present study, a total of 160 patients with cataract were included. 80 patients were included in group A and 80 patients were included in group B. Mean age of the patients was 64.83 +/- 8.93years in group A and 65.07 +/- 8.61 years in group B. There was no significant difference in both the groups in regard of age distribution. Similarly in a study conducted by Hany M. El Ibiary., *et al*. [17] evaluating the effect of Clear Corneal Incision (CCI) on

corneal higher order aberrations after phacoemulsification, mean age in OCCI group was 62.72 +/- 7.83 years and in single incision group was 62.31 +/- 7.31 years. In a study conducted by Thool., *et al*. [18] on outcomes of CCI on steep meridian in eyes with pre existing astigmatism after phacoemulsification, mean age of the patients was 61.86 +/- 10.38 years. Thus, the mean age in our study was similar to other reported Indian and foreign studies.

The percentage of males belonging to group A in our study was 55% and percentage of males in group B was 57.5%. There was no significant difference with respect to gender distribution in the both the groups. Our results were in concordance with the results obtained by various other authors in regards to gender wise distribution. In the study conducted by El Ibiary., *et al*. [17], 46.9% patients were males in OCCI group and 56.2% patients were males in single CCI group. Their studies also didn't show any significant difference with respect to gender wise distribution in both the groups.

In our study, 31.25% of patients had UCVA between 6/24 - 6/36 preoperatively and 68.75% patients had UCVA < 6/60. At post operative day 7, 35% of patients had UCVA between 6/6 - 6/9. At 1 month visit, 68.75% of patients had UCVA between 6/6 - 6/9. At 3 month and 6 months postoperative visit, 95% of patients had UCVA between 6/6 - 6/9. None of the patients had UCVA less than 6/18 in group A. In group B, 32.5% of patients had UCVA between 6/24 - 6/36 preoperatively and 67.5% patients had UCVA < 6/60. At post operative day 7, 27.5% of patients had UCVA between 6/6 - 6/9. At 1 month visit, 40% of patients had UCVA between 6/6 - 6/9. At 3 months, 53.75% and at 6 months postoperative visit, 55% of patients had UCVA between 6/6 - 6/9. The difference in UCVA was significant at 1 month, 3 months and 6 months postoperative visits in both the groups (p value <0.05). The significant difference in UCVA of both the groups might be due to higher range of post operative residual astigmatism present in group B as compared to group A. No studies are available which have compared UCVA outcomes between OCCI and CCI groups. BCVA was between 6/6 - 6/9 in 88.75% patients at postoperative day 7 in group A. At 1 month, 3 month and 6 months postoperatively, BCVA was between 6/6 - 6/9 in 96.25%, 97.5% and 97.5% respectively in group A. BCVA was between 6/6 - 6/9 in 87.5% patients at postoperative day 7 in group B. At 1 month, 3 month and 6 months postoperatively, BCVA was between 6/6 - 6/9 in 93.75%, 95% and 95% respectively in group B.

In our study we compared the effect of OCCI given at the steeper meridian at the end of phacoemulsification surgery as a measure to reduce the pre existing astigmatism along with single clear corneal incision given at the steeper meridian to perform the phacoemulsification procedure. The mean preoperative astigmatism in group A and group B was 1.40+/- 0.31 D and 1.34+/- 0.26 D respectively. There was no significant difference in preoperative astigmatism between both the groups. The mean astigmatism in group A at post operative day 7, 1 month, 3 months and 6 months follow up visit was 1.19 +/- 0.20 D, 0.91 +/- 0.18 D, 0.68 +/- 0.13 D and 0.61 +/- 0.14 D. In our study, the mean astigmatic correction was 0.79 diopters at the end of 6 months in group A. In group B, we didn't give OCCI while performing phacoemulsification and noted the effect of single clear corneal incision given on the steeper meridian. The preoperative mean astigmatic value was 1.34+/- 0.26 D in group B. The mean astigmatism at in group B at post operative day 7, 1 month, 3 months and 6 months follow up visit was 1.27 +/- 0.23 D, 1.14 +/- 0.20 D, 1.07 +/- 0.18 D and 0.98 +/- 0.18 D. Thus, the mean astigmatic correction at 6 months in group B was 0.36 D. There was a significant decrease in mean astigmatic error in both the groups when compared with the mean preoperative astigmatic values (p Value < 0.05). The mean astigmatic correction was more in group A (OCCI) as compared to group B (single CCI) at the end of 6 months (p Value < 0.05).

Similarly, El Ibiary., *et al*. [17] in their study showed the mean astigmatic correction of 0.68 D in OCCI group and the mean astigmatic correction of 0.42 D in the single incision group. There study showed significant reduction in mean astigmatic correction (p Value < 0.05).

In a study conducted by Bhalla., *et al*. [19] the mean astigmatism was reduced from 1.16 ± 0.32D WTR preoperatively to 0.46 ± 0.28 WTR at 3 months postoperatively in patients who had opposite clear corneal incision along with 2.8 mm corneal incision for phacoemulsification which was further extended to 3.2 mm while injecting the IOL. The preoperative astigmatism of -1.25 ± 0.32D ATR was reduced to -0.38 ± 0.31D ATR 3 months postoperatively.

Yuepingren., *et al*. [20] studied the effect of phacoemulsification with 3.0 and 2.0 mm Opposite Clear Corneal Incisions for correction of corneal astigmatism. In their study, the corneal astigmatism reduction was 0.61 ± 0.38 D in the 3.0 mm OCCIs group and 0.29 ± 0.29 D in the 2.0 mm OCCIs group. Their study showed that 3.0 mm OCCIs on steeper meridian were effective for correcting mild-to-moderate corneal astigmatism during cataract surgery, exerting no additional impact on corneal aberration compared with Smaller CCI. Our results were in concordance with these studies as we

found a mean corneal astigmatism reduction of 0.79 D in the 3.2 mm OCCI group.

Tardos., *et al*. [21] reported the mean astigmatic correction of 0.50 D after using OCCI technique. Similarly, Bazzazi., *et al*. [11] found the mean preoperative corneal astigmatism in the group of patients with > 1D WTR astigmatism undergoing phacoemulsification with superior incision and an opposite clear corneal incision to be 1.82 ± 0.86D WTR, which decreased to 1.31 ± 0.59D WTR postoperatively. The induced astigmatism was -0.50 ± 0.79D ATR.

In another study conducted by Binayi Faal N., *et al*. [22], the decrease in astigmatism was 0.76 D during the 1st month after surgery, while it was 0.85 D at 12 months postoperatively. Our study similarly showed more decline in mean preoperative astigmatism with OCCI as compared to single CCI.

Khokhar., *et al*. [23], in their study, had the mean preoperative and postoperative topographic corneal astigmatism of 2.51 +/- 0.92 D and 0.91 +/- 0.54 D, respectively, in OCCI Group and 2.16 +/- 0.80 D and 1.57 +/- 0.70 D, respectively, in single CCI Group. Mean astigmatic correction was 1.66 +/- 0.5 D and 0.85 +/- 0.75 D in OCCI Group and CCI Group, respectively.

Simon and Desatnik [24], had 34 patients in their study who underwent clear cornea phacoemulsification cataract extraction with 3.2-mm OCCIs. Preoperative astigmatism was 2.6 ± 1.2 D and postoperative astigmatism was 1.4 ± 0.9 D with a mean correction of 1.3 ± 0.9 D. Hence, these studies also showed more mean astigmatic correction with OCCI as compared to single CCI, however, the results shown in our study are within the lower range as compared with the previous studies.

Since the residual astigmatism after phacoemulsification can render the patient spectacle-dependent and can lead to patient's dis-satisfaction, it is important to address astigmatism as well during cataract surgery, so as to achieve postoperative spectacle independence [25]. Thus, paired OCCI on the steep axis is technically an easy method that doesn't require additional equipments. The same 3.2 mm knife used by most surgeons for routine phacoemulsification cataract surgery can be used for making OCCI, therefore no additional cost is entailed. However, this method is more effective for correcting mild to moderate corneal astigmatism than higher degrees of astigmatism. So, it is recommended to use either an alternative method or a combination of two or more method to correct a higher preoperative astigmatism error.

The disadvantage of OCCI include placement of another incision with its antecedent risks of shallow anterior chamber, besides theoretically increased risk of endophthalmitis. Another potential disadvantage is the lack of desired effect as was observed in four of our patients in group A. Fortunately, in our study we did not encounter any endophthalmitis in trial patients. Some patients may report increased post operative foreign body sensation due to an additional incision but that was not the case either in the present study.

Limitations of Study

There are some limitations of present study. Sample size was limited, the range of preoperative astigmatism taken was smaller and the follow up period was short at only six months. Future studies are required with a large sample size and longer follow ups to better elucidate the long term effects of OCCI on astigmatism and vision related quality of life.

Conclusion

Being an advancement in refractive lenticular surgery, Opposite Clear Corneal Incision is a safe and cost effective procedure in reducing mild to moderate preexisting corneal astigmatism if reliable preoperative corneal topography data using Pentacam are available. They may be employed as an additional armamentarium during phacoemulsification surgery to further enhance visual outcomes and patient satisfaction.

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None of the authors have any relevant financial interest to disclose.

Conflict of Interest

Nil.

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