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IMPACT OF 2.8MM CLEAR CORNEAL INCISION ON REFRACTIVE OUTCOME IN PHACOEMULSIFICATION PATIENTS

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ABSTRACT

Objective: To determine the keratometric change and resultant post-operative refraction of routine cataract patients, after a clear corneal incision of 2.8mm on the steeper meridian.

Study Design: Quasi-experimental study.

Place and Duration of Study: Combined Military Hospital Kharian, from Jul 2017 to Jun 2018.

Methodology: A total of 123 cataract patients were included in this study. Pre-operative keratometric readings were compared with post-operative readings, after a clear corneal incision (CCI) of 2.8mm made during phacoemulsification procedure. Opposite clear corneal incision was made in astigmatism over 1 diopter.

Results: Patients were monitored for six weeks post-operatively. It showed that a reduction of cylinder (0.81 ± 0.60 vs. 0.92 ± 0.54, *p*0.035) was present if the incision was at or near the steeper meridian. In 99 patients (80.4%) the astigmatism remained the same or there was a reduction in the power of preoperative cylinder. The remaining 24 patients had either no preoperative astigmatism in 11 patients, (8.94%), or the power of cylinder increased in 13 patients (10.57%) secondary to surgically induced astigmatism (SIA). Temporal clear corneal incision (CCI) made a lesser impact on the surgically induced astigmatism (SIA) than other quadrants.

Conclusion: The results confirmed that steeper axis clear corneal incision (CCI) CCI is effective in reduction of post-operative astigmatism. These incisions in conjunction with surgeon's surgically induced astigmatism (SIA) play an important role in predicting postoperative visual outcome.

Keywords: Clear corneal incision, Keratometry, opposite clear corneal incision, Steep meridian, Surgically induced astigmatism.

INTRODUCTION

In the last hundred years, ophthalmology has advanced to a stage that cataract surgery is not merely a change of cloudy crystalline lens but a refractive surgery itself. Nowadays patients are usually reluctant to use glasses or contact lenses after surgery[1]. Thus the expectation of every patient after cataract surgery is to achieve emmetropia for distance without glasses. This predictability of result post-operatively, is complicated by the pre-existing corneal shape and the change induced by the surgery itself.

The subject of surgically induced astigmatism (SIA) is of importance as the amount of astigmatism to be corrected at the time of surgery, is a vector sum of pre-operative corneal astigmatism plus any SIA. The understanding and application of one's own (SIA) is not only crucial for toric IOL implantation but also an important consideration for achieving proficiency in cataract surgery. Smaller incisions minimize SIA which is one of the main factors influencing vision quality after cataract surgery[2]. There are two factors that determine SIA; incision size and its location[3]. The flattening effect is more in corneal incision given on steeper meridian having with the rule astigmatism (900) than those having against the rule astigmatism (1800).

Simplest way to calculate SIA is post-operative K readings minus pre-operative K readings. To be more accurate, SIA is calculated by putting data of 60 cases online to a calculator[4]. The importance of SIA is that On-axis incision will always diminish the post-operative astigmatism

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and CCI given in the superior and nasal areas of the cornea causes higher post-operative refractive shift than the Temporal quadrant.

Opposite Clear Corneal Incision (OCCI) could further have an additive effect in reducing the astigmatism, if desired[5]. Paired OCCI have larger effect in with the rule astigmatism (WTA) as compared to against the rule astigmatism (ATA). Astigmatism of 1.5-2.0 D can be corrected by this procedure if incision on the steeper meridian is used. Furthermore if a toric IOL is planned for the patient, then determine vector sum of pre-existing astigmatism and SIA, before an appropriate implanted IOL is selected[6].

Another method to treat 1 to 3D of pre-existing astigmatism are the Peripheral corneal-relaxing incisions (PCRIs), previously called limbal relaxing incisions (LRI). However, due to various side effects like neurotropic keratopathy, patient discomfort, gapping of incision and inadvertent perforation of cornea, this procedure is not very popular among the ophthalmic surgeons. These incision lengths are as long as the clock hours in diopters as measured by keratometer[7]. In these patients phacoemulsification incision has to be made through these PCRIs, whichever is closest to the surgeon in the superior or temporal quadrant. This study was aimed at predicting the keratometric change after a CCI of 2.8mm at steeper meridian, resulting in either reduction of pre-existing astigmatism or at the very least not to increase it.

METHODOLOGY

This quasi-experimental study was carried out in CMH Kharian, from July 2017 to June 2018. The study was approved by Hospital Ethics Committee of CHM Kharian. A total of 123 patients fulfilling inclusion and exclusion criteria, were recruited into the study using non-probability consecutive sampling technique. The sample size was calculated by using WHO sample size calculator considering prevalence of uncomplicated cataract among general public of 8.2%, 8.95% level of significance, 80% study power and also bearing in mind attrition and loss to follow-up. Informed written consent was taken from all patients prior to their enrolment in the study. Adult patients of over 20 years of age were included, having reduced vision due to cataract formation.

Patients having any corneal opacity, dry eyes, advance pterygium, and degenerative diseases were excluded from this study. Any previous surgery on the affected eye was also excluded from the study. Patients who had per-op complications like posterior capsular rupture (PCR) were excluded too. Patients having irregular astigmatism due to any cause were also excluded from this study. Any astigmatism of over 2.5D was also excluded. Deep-set eyes and inferior nasal steep-axes patients were also excluded in this study. These patients, although not included in the study, were given temporal incisions so as not to further increase the preexisting astigmatism.

All patients included in this study were evaluated for their best corrected vision on Snellen chart. Slit lamp examination was done and Intra-ocular pressure was taken. The steeper axis was determined pre-operatively using automated keratometry (Nidek ARK1, Nidek Co Ltd Japan). Biometry and IOL calculation was done by contact method (Quantel Medical Axis II). A scan was done by single operator and SRK-T formula was used. Dilated fundus examination was done where possible.

At the time of surgery, patients were marked pre-operatively for 0-180 axis, with toric corneal marker in the operating room in sitting position. Incyclo-rotation of the eye, when patient assumes the supine position was taken into account while marking the eye for horizontal axis.

Steeper axis was determined pre-operatively and marked on the patient document. Topical anaesthesia using Proparacaine hydrochloride 0.5% (Alcaine) was used in all cases. All patients were operated by single surgeon. Phacoemulsification was done using Alcon Laureate system (Alcon Fort Worth TX, USA) and 2.8mm coaxial tip was used. A two-step Clear Corneal Incision

(CCI) was given via 2.8mm keratome on or within 5 degrees of steeper axis (where feasible) in all patients. Patients having astigmatism of over 1D were given Opposite Clear Corneal incisions (OCCI), where possible. Viscoelastic dispersive gel (Rayner Methylvisc 2.0%) was instilled and a capsulorhexis of 5-5. 5mm was made using a bent insulin needle for cystitome. Hydromaneuvers, phaco-chop technique, cortical aspiration and IOL insertion using a 2.8mm tip size delivery system was used. Visual acuity and keratometric readings were again assessed post-operatively at one week, third week and then at six weeks. Surgically Induced Astigmatism (SIA) was calculated by using online calculator[1]. Outcome measures were analyzed in the form of any change in the power and axis of cylinder from the pre-operative state. The data obtained from patients was entered in data management software (IBM SPSS version 23.0) for analysis. Descriptive statistics for normally distributed data were calculated and reported as mean and standard deviation while for categorical variables frequencies and percentages were reported. In order to compare the main study variable pre and post operatively, paired samples t-test was used with an alpha level of 0.05.

RESULTS

In this quasi-experimental study 126 patients were initially enrolled. Three patients were lost to follow-up because of various domestic reasons. The average age of the patients was 66 years (26 years to 85 years).The male patients predominated at 90 eyes (73.17%) and female patients were 33 (26.83%) The baseline clinical characteristics were summarized in table 1.The mean with the rule astigmatism (WTR) was observed in 19 patients (15.44%). Against the rule astigmatism (ATR) was present in 80 patients (65.04%). No astigmatism or only 0.25 D astigmatism was present in 24 patients (19.51%) and was considered as having no pre-operative astigmatism.

Almost equal number of right eyes 61 (49.59%) and left eyes 62 (50.41%) were operated. OCCI was given in 32 patients (26.01%) having astigmatism of over 1.0 D. As three patients were lost to follow-up, remaining 123 patients were checked for their last follow-op at 6 weeks. Data showed that pre-operative astigmatism decreased in 45 patients (36.59%), remained the same in 54 patients (43.90%) and increased in 24 patients (19.51%). In the last category 11 out of 24 patients had either no astigmatism or 0.25D of astigmatism pre-operatively. All 24 patients were given temporal incisions. As such the SIA induced in these patients was 0.5D, though minimal, and hence the increase in post-operative astigmatism.

Table-I: Baseline characteristics of study population.

Clinical Characteristics	
Age in years	66 Years
Gender	**n (%)**
Male	90 (73.17)
Female	33 (26.83)
Eye	**n (%)**
Right	61(49.59)
Left	62 (50.41)
Post-Op K Status	**n (%)**
Decreased	45 (36.59)
Increased	24 (19.51)
Remained the same	54 (43.90)
Astigmatism Type	**n (%)**
With the rule	19 (15.44)
Against the rule	80 (65.04)
No astigmatism	24 (19.51)

Table-II: Comparison of pre and post-operative keratometric (K-value).

Keratometric Finding	**Value**	***p*-value**
Pre-Op K	0.92 ± 0.54	0.035
Post-Op K	0.81 ± 0.60	

Broadly classifying, post-operative astigmatism remained same in 59 (46.8%) patients while decreased and increased in 43 (34.1%) and 24 (19.0%) patients, respectively. There was a significant decrease observed in mean K value post-operatively as compared to pre-operative value (0.81 ± 0.60 vs. 0.92 ± 0.54, 95% CI 0.09–0.20, p=0.035) as shown in table-II.

To further conclude this study a satisfactory Level of post-operative refraction was determined and an arbitrary Scale was made. In this

analysis, satisfactory level was determined as achieving a post-operative refraction within ± 0.75 diopter spherical of emmetropia, or the cylindrical value of at least one meridian was within ± 0.5 diopter. According to this study 99 patients (80.48%) achieved the desired results. The remaining 24 patients (19.51%) either had biometric error or higher pre-operative cylinder which could not be corrected by CCI or OCCI. These patients were advised Toric IOL pre-operatively, but due to financial constraints were refused. In 2 patients IOL had to be exchanged one week after implantation due to Biometric error. Peripheral Corneal Relaxing incision was not used in any patient.

DISCUSSION

Astigmatism of cornea after phacoemulsification surgery depends on various parameters such as incision location, configuration, number of incisions, any suture applied and center from the optical center of cornea[9,10]. Astigmatism of even as low as one diopter after cataract surgery can significantly affect the vision and lead to unsatisfactory results[11].

There has been no study which compares pre-op and post op corneal astigmatism after phacoemulsification using steeper axis clear corneal incision (CCI) in our population. In one large study by Hoffer *et al*, up to 30% patients had more than 1 D of astigmatism before surgery, which required correction during surgery[12]. Similarly in our study we found that 34% patients had a pre-op astigmatism of >1D. For the determination of this pre-operative astigmatism, keratometery is done either on manual or automated keratometer. This only determines the anterior corneal astigmatism, but practically only these are used in Biometry, which determines the Intra Ocular Lens (IOL) power used for visual rehabilitation.

It has been shown in many studies conducted by Park *et al*, and Zhang *et al*, that posterior surface of the cornea induces significant astigmatism and can affect the total corneal astigmatism[13,14]. This is highly significant, especially in Toric IOL calculations. Incision given in the cornea during phacoemulsification surgery can alter this pre-operative corneal astigmatism, resulting in shift of both power and axes of the cornea. The moment a keratome passes through the corneal stroma, the characteristics of cornea changes. This alters the corneal dome and hence the induced astigmatism.

Thus comparing post-operative K readings with the pre-operative value, will determine what has been changed during the corneal incision. Marek *et al*, reported that same sized biplanar and triplaner incision are statistically equal in the formation of Surgically Induced Astigmatism (SIA)[15].

Agarwal *et al*, concluded from their study that corneal incision at steep axis is an effective technique in reducing pre-op astigmatism[16]. Results of our study also demonstrated that pre-op astigmatism was either reduced in 34.1% patients or remained same in 46.8% patients.

Joshi *et al*, reported that Temporal clear corneal incision is quite stable and has minimal effect on corneal astigmatism[17]. Since 65% patients in our study had with the rule astigmatism and another 19.51% patients had no pre op astigmatism, their main port CCI was located in temporal zone and hence had minimal SIA.

Al Mahmood *et al*, concluded from their study that although clear corneal incisions are very appealing, yet they are not completely free of complications like poor wound healing, irregular astigmatism and endothelial cells loss[18]. However no such complications were seen in our patients.

Poll *et al*, suggested that Toric IOLs reduce cylinder up to 58.4% of the initial Magnitude. Whereas PCRIs is effective in reducing cylinder up to 60%, with 79% corrected to less than 1D and 59% less than 0.5D[7]. On the other hand OCCI is economical and faster to perform than Toric IOL and PCRIs, respectively. However in our study 14.6% patients who had higher pre-operative cylinder which could not be corrected by CCI or OCCI were advised Toric IOL preoperatively,

but due to financial constraints were refused. Peripheral Corneal Relaxing incisions were not used in any patient.

CONCLUSION

A favorable visual outcome is present once the desired CCI incision is used on axis, with consistency in SIA. Thus we can predict the desired postoperative refractive outcome, and adjustments can be made accordingly in the pre-operative period in biometric calculations and also preoperatively in choosing type and location of CCI. Further studies involving larger patient groups are needed to confirm the scope of our findings.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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