Study Of Change In Vision And Astigmatic Refractive Error Postoperatively In Patients Undergoing Clear Corneal Phacoemulsification Surgery With Foldable Intra Ocular Lens

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Abstract: Background: Surgically induced astigmatism (SIA) is astigmatism that is created by incisions in cataract surgery; change in both the power and to a lesser degree, orientation of the principal meridians following a corneal incision. Present study was aimed to study change in vision and astigmatic refractive error post operatively in patients undergoing clear corneal phacoemulsification surgery with foldable intra ocular lens. Material And Methods: Present study was hospital based, prospective, observational study, conducted in patients posted for phacoemulsification cataract surgery with foldable IOL with clear cornea and regular astigmatism on keratometry, with preoperative astigmatism more than or equal to 0.5D on keratometry, willing to participate in study. Result: In present study, 44 eyes of 44 patients were considered for study. Mean age of the patient is 56.98 ± 5.98 years. There were 29 males and 15 females. Right eye surgery was done in 18 eyes and left eye surgery was done in 26 eyes. Refractive acceptance preoperatively was 0.50 D to 2.0 D. Mean IOL power was 22.7 ± 0.801. Preoperatively mainly eyes had best visual activity between 6/24 to 6/18 while visual activity range from 6/60 to 6/12. Improved vision postoperatively day 90th where vision was 6/6 unaided in 24 eyes out of 44 eyes and 6/9 in 14 eyes respectively. Majority of patients had Preop Keratometric Difference (K1-K2) of 1.5 D, all required LRI Incisions length of 4 clock hours (60°). On postoperative 90th day, improved dioptric difference by automated keratometry as compared to preoperative values. LRI was slightly more effective in patients above 50 years as compared to in patients below 50 years. Conclusion: In patients undergoing clear corneal phacoemulsification surgery with foldable intra-ocular lens, postoperatively improved vision and reduced astigmatic refractive error is noted. [Sahare H Natl J Integr Res Med, 2021; 12(6):20-25]

Key Words: Clear Corneal Phacoemulsification, Foldable Intra-Ocular Lens, Astigmatic Refractive Error, Limbal Relaxing Incision

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Introduction: Age-related cataract is the principal cause of blindness and visual impairment in the world. Phacoemulsification is the main surgical procedure used to treat cataract. Surgically induced astigmatism (SIA) is astigmatism that is created by incisions in cataract surgery, change in both the power and to a lesser degree, orientation of the principal meridians following a corneal incision[1].

Options for correcting astigmatism at the time of cataract surgery are incision placement on the steep axis of corneal astigmatism, single or paired peripheral corneal relaxing incisions, and Toric intraocular lens implantation Limbal Relaxing Incisions, or LRIs, are partial thickness corneal incisions strategically placed to reduce or eliminate pre-existing astigmatism during cataract surgery or refractive lens exchange surgery[2,3]. With precise measurements and marking of the eye prior to surgery, an incision is fashioned at limbus (the junction between the corneal and sclera) in the axis of steepest curvature, thereby "relaxing" that axis and leaving the corneal in a rounder shape[4].

As with other cataract extraction procedures, an intraocular lens implant (IOL), is placed into the remaining lens capsule.

For implanting a foldable IOL, the incision does not have to be enlarged. It is then inserted and placed in the posterior chamber in the capsular bag (in-the-bag implantation). Present study was aimed to study change in vision and astigmatic refractive error postoperatively in patients undergoing clear corneal phacoemul sification surgery with foldable intra ocular lens.

Material & Methods: Present study was hospital based, prospective, observational study, conducted in department of Ophthalmology, at Topiwala National Medical College and BYL Nair Ch. Hospital, Mumbai, India. Study duration was of 2 years (July 2018 to June 2019). Institutional ethical committee approval was taken for present study.

Inclusion Criteria: Patients posted for phacoemul sification cataract surgery with foldable IOL with clear cornea and regular astigmatism on keratometry, with preoperative astigmatism more than or equal to 0.5D on keratometry, willing to participate in study

Exclusion Criteria: Patients with decompensated cornea, corneal tear repair, corneal ulcers, corneal opacities and irregular astigmatism on keratometry. Patients with Collagen Vascular Disease like Pterygium. Patients with history of optical keratoplasty, wound burn during Surgery Patients not fit for Phacoemulsification surgery with foldable IOL.

Study was explained to patients & a written informed consent was taken for participation.

Preliminary data of patient such as age, sex, occupation, detailed history, history of use of glasses, duration of onset of diminution of vision.

Investigations such as CBC, Fasting Blood Sugar, Post Prandial Blood sugar, Lipid profile, ECG were done in all patients.

Detailed general examination was done, followed by ophthalmic examination (local examination, slit lamp examination, indirect Ophthalmoscopy, Pachymetry, Anterior Segment OCT, Gonioscopy, Intraocular pressure with applanation tonometer & whenever indicated Bscan was done.

All patients underwent phacoemulsification cataract surgery under local or general anesthesia, adequate precautions were taken to prevent infection and Wound Leak.

Patients were followed up on postoperative day1, day 7, at the end of 1 month and 3 months.

At every visit vision was assessed. Indirect ophthalmoscopy will be done for posterior segment, slit lamp examination wound integrity, wound leakage, anterior chamber depth, any infection.

Parameters such as astigmatic refractive error (cylindrical power), keratometry (Manual Keratometry and Auto Keratometry) findings, best corrected visual acuity by Snellen's chart or ETDRs chart (BCVA), Spherical refractive error (spherical power), Fundus examination & Complications of Limbal Relaxing Incision if any were noted at each visit.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version.

Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables.

Difference of proportions between qualitative variables was tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

Results: In present study, 44 eyes of 44 patients were considered for study. Mean age of the patient is 56.98 ± 5.98 years.

There were 29 males and 15 females. Right eye surgery was done in 18 eyes and left eye surgery was done in 26 eyes. Refractive acceptance preoperatively was 0.50 D to 2.0 D. Mean IOL power was 22.7 ± 0.801.

Table 1: General Characteristics

General Characteristics	Frequency	Percentages
Mean Age (Years)	56.98 ± 05.98	
Gender (Males / Females)	29 / 15	65 %/ 35 %
Side (Right Eye/ Left Eye)	18/ 26	40.90 %/ 59.10 %
Mean IOL Power	22.7 ± 0.801	

Preoperatively mainly eyes had best visual activity between 6/24 to 6/18 while visual activity ranges from 6/60 to 6/12.

Improved vision postoperatively day 90th where vision was 6/6 unaided in 24 eyes out of 44 eyes and 6/9 in 14 eyes respectively.

Table 2: Best Corrected Visual Acuity As Per Snellen's Chart

BCVA as per Snellen's Chart (LogMAR)	Preoperatively	Postoperative 90th day
	Frequency (%)	Frequency (%)
6/60 (0.10)	03 (06.81 %)	0
6/36 (0.17)	05 (11.36 %)	0
6/24 (0.25)	15 (34.09 %)	0
6/18 (0.33)	19 (43.18 %)	02 (04.54 %)
6/12 (0.50)	02 (04.54 %)	04 (09.09 %)
6/9 (0.67)	0	14 (31.81%)
6/6 (1.00)	0	24 (54.54 %)

Majority of patients had Preop Keratometric Difference (K1-K2) of 1.5 D, all required LRI Incisions length of 4 clock hours (60°).

Table 3: Comparisons Of Length Of LRI According To Preop Keratometric Difference

LRI Incisions Length	Preop Keratometric Difference (K1-K2)					
	0.50D	0.75D	1.00D	1.50D	1.75D	2.00D
2 Clock Hours (30°)	01	-	-	-	-	-
3 Clock Hours (45°)	-	01	10	-	-	-
4 Clock Hours (60°)	-	-	-	24	05	-
6 Clock Hours (90°)	-	-	-	-	-	03

On postoperative 90th day, improved diopteric difference by automated keratometry as compared to preoperative values.

Table 4: Change In Diopteric Difference By Automated Keratometry

Diopteric Difference In Keratometric Value (K1-K2)	Preoperatively	Postoperative 90th Day
	Frequency (%)	Frequency (%)
0.50D	1 (02.27 %)	24 (54.54 %)
0.75D	1 (02.27 %)	14 (31.81%)
1.00D	10 (22.75 %)	2 (04.54 %)
1.25D	9 (20.45 %)	2 (04.54 %)
1.50D	15 (34.09 %)	1 (02.27 %)
1.75D	05 (11.36 %)	1 (02.27 %)
2.00D	03 (06.81 %)	0

In 05 out of 10 patients above 50 years (50 %) got residual keratometric difference of 0.50D (emmetropic) as compared to 19 out of 34 (55.88%) patients below 50 years. Thus, LRI was slightly more effective in patients above 50 years as compared to in patients below 50 years. In 08 out of 18 LE (44.44%) got residual keratometric difference of 0.50D (emmetropic) as compared to 16 out of 26 RE (61.53%) thus, LRI was more effective in LE as compared to RE.

Table 5: Comparison Of Effectiveness Of LRI

Characteristic	Preop (Without LRI)	Postop (LRI With Emmetropia Of Residual Error 0.50D)
Age (Years)		
Below 50	10	05
Above 50	34	19
Side		
Right Eye	18	08
Left Eye	26	16

The mean dioptric power of the central cornea before surgery at presentation was +42.89 ± 0.88. The mean dioptric power of the cornea at postoperative day 1 after surgery was 42.80 ±

0.64 and at postoperative day 7 was 42.72 ± 0.65 D and at postoperative day 30 was 42.72 ± 0.81 and at postop day 90th was 42.71 ± 0.54 D. The mean astigmatic power of the central cornea before surgery was 1.70 ± 0.54 D. At postoperative day 1 after surgery, the mean astigmatic power of the cornea was 0.94 ± 0.81 D and 2.08 ± 0.60 D at postoperative day 7 after surgery and at postoperative day 30 was 0.41 ± 0.01D and 90th day was 0.25 ± 0.21 D. There was decrease in corneal astigmatism after limbal relaxing incisions. The difference was statistically significant (p<0.001). Change in Refractive Index preop and postop was statistically significant (p-value <0.001). Change in BCVA preop and postop was statistically significant (p-value <0.001). Visual outcome a change after limb relaxing incisions statistically significant. Keratometry changes preop and postop is statistically significant with (p<0.001).

Table 6: Mean Diopteric Power, Astigmatic Power & Visual Acuity Preop And Postop

Visits	Pre-Op Visit	Postop Day 1	Postop Day7	Postop Day30	Postop Day90
Mean Diopteric Difference Power	42.89 ± 0.88	42.80 ± 0.64	42.72 ± 0.65	42.72 ± 0.81	42.71 ± 0.54
Mean Astigmatic Power (In D)	1.70 ± 0.54	0.94 ± 0.81	0.51 ± 0.50	0.42 ± 0.40	0.25 ± 0.21
BCVA	0.31 ± 0.11	0.21 ± 0.02	0.17 ± 0.001	0.09 ± 0.06	0.05 ± 0.02

Discussion: Phacoemulsification is a modern cataract surgery in which the eye's internal lens is emulsified with an ultrasonic hand piece and aspirated from the eye. The foldable IOL requires, few or no stitches and the patient's recovery time is usually shorter[2,3]. Preexisting corneal astigmatism at the time of cataract surgery can be treated by manipulation of cataract incision, limbal relaxing incisions (LRIs), astigmatic keratotomy, paired opposite clear corneal incision, implantation of toric intraocular lens, photorefractive keratotomy (PRK), laser in situ keratomileusis (LASIK) and recently penetrating limbal relaxing incisions (PLRIs) [5]. Limbal Relaxing Incisions are an effective way to reduce astigmatism at the time of cataract surgery. No adjustment to the surgeon's preferred position of the cataract incision is needed with LRIs.

Due to their placement at the outermost periphery of the cornea and their similarity to conventional cataract incisions, these incisions are simple to perform and unlikely to cause complications. The forgiving nature of the procedure represents another advantage[6].

LRIs does not lead to corneal haze that interfered with phaco surgery as the incisions were placed in the most peripheral cornea as reported by other studies. Advances in cataract and refractive surgery techniques, nomograms and intraocular lens (IOL) technology allow greater control over the patient's postoperative refractive outcome and visual resolution. A surgeon may become more comfortable with one particular technique as compared to another and should, therefore, choose an approach which works best in his or her hands[5,6].

In our study, in the LRI group we found that the mean preoperative astigmatism at postoperative day 1 after surgery, the mean astigmatic power of the cornea was 0.948±0.810D and 0.508±0.509D at postoperative day 7 after surgery and at postoperative day 30 was 0.416±0.406D and day 90th was 0.254 ± 0.210 D respectively.

There was decrease in corneal astigmatism after limbal relaxing incisions. Visual outcome a change after limb relaxing incisions statistically significant. Corneal astigmatism improved and 24 eyes were emmetropic (0.50 DC) on postop day 90th with remaining residual cylindrical power ranges between 0.75 DC to 1.25 DC respectively.

On postoperative day 44 all eyes were emmetropic with refractive power of 1.416.

In the study by Gross RH et al. [7], mean target induced astigmatism was 1.50 D and 1.38 D respectively, with 1.02 D and 1.23 D surgically induced astigmatism (P = .21), resulting in the femtosecond arcuate keratotomy group having a smaller difference vector (1.17 D versus 0.89 D; P = .02) and a greater correction index (0.48 versus 0.73; P = .02). 44 % of patients in the femtosecond arcuate keratotomy group and 20% in the LRI

group attained a postoperative cylinder of less than 0.50 D, difference was statistically significant. The femtosecond arcuate keratotomy group achieved a higher correction index and a smaller difference vector. The femtosecond arcuate keratotomy patients showed less postoperative cylinder than LRI patients[8].

Budak et al. [8], reported an absolute decrease in mean astigmatism by 44%, Bayramlar et al. [9], as 52%, Kaufmann et al. [10], as 25% & Carvalho et al. [11], as 50%. Average central corneal power was not significantly modified by LRIs, thus confirming the value of the coupling ratio of approximately 1:1 previously published.

Gills JP et al.[12], demonstrated statistically significant improvement after surgery. At the end of the follow-up period, the UCVA was statistically better for the patients with LRIs.

Hayashi Ken et al.[13], noted that LRIs group showed significant reduction in the mean topographic astigmatism from 1.48 ± 0.35 D preoperatively to 0.37 ± 0.14 D postoperatively (P < .0001) after one month. The mean magnitude of the surgically induced astigmatism (SIA) read 0.416 ± 0.406 D and 0.254 ± 0.210D by the end of the 1st, the 3rd month postoperatively in LRIs group, which was slightly lower than the target-induced astigmatism (TIA). The difference in SIA between the LRI statistically significant by the end of the 1st and 3rd month postoperatively (P < 0.001). The mean correction index (CI) was less than 1, which indicated under- correction effect of limbal relaxing incision.

Incisional surgical correction of astigmatism can be performed as part of cataract surgery to optimize the refractive and visual outcome for cataractous cases with preexisting corneal astigmatism[12]. Disadvantages of the LRI includes requiring special instrumentation (diamond knife, or preset depth guarded disposable blades), possible weakening of the integrity of the globe and moderate variability in accuracy, presumably resulting from variations in individual wound healing pattern. LRIs can correct astigmatism up to 2D. LRIs also leave the central cornea untouched for other corneal refractive interventions for residual ametropia[15].

Recently the concept of penetrating limbal relaxing incisions (PLRIs) was introduced. Penetrating limbal relaxing incisions entail performing two full thickness incisions using a keratome knife along the steepest meridian, in addition to the clear corneal stab incision of the phacoemulsification[6]. Penetrating limbal relaxing incisions are simpler; do not require special instrumentation as in limbal relaxing incisions. These LRIs did not lead to corneal haze that interfered with phaco surgery as the incisions were placed in the most peripheral cornea as reported by other studies[6].

Conclusion: In patients undergoing clear corneal phacoemulsification surgery with foldable intra-ocular lens, postoperatively improved vision and reduced astigmatic refractive error is noted.

Limbal relaxing incision during clear corneal phacoemulsification surgery with foldable intra ocular lens is safe, quick, and helpful in reducing preexisting astigmatism till 2D and also in patients who are non-affording to pay for surgery with Toric lenses which is costly.

References:

1. Sigireddi RR, Weikert MP. How much astigmatism to treat in cataract surgery. Curr Opin Ophthalmol. 2020 Jan;31(1):10-14. doi: 10.1097/ICU.0000000000000627. PMID: 31770161.
2. Sinjab MM. Introduction to astigmatism and corneal irregularities. In: Sinjab MM, Cummings AB, eds. Customized laser vision correction. Cham: Springer International Publishing; 2018:1-64. doi:10.1007/978-3-319-72263-4_1
3. Mehvash Hussain, Mohammad Muneer Quraishy Limbal Relaxing Incision during Phacoemulsification for the Correction of Astigmatism", Pak J Ophthalmol 2015, Vol. 31 No. 2, P-77-82.
4. Nichamin LD. Astigmatism control. Ophthalmol Clin North Am. 2006 Dec;19(4):485-93. doi: 10.1016/j.ohc.2006. 07.004. PMID: 17067903.
5. Scialdone A, Raimondi G, Monaco G. In vivo assessment of higher-order aberrations after AcrySof toric intraocular lens implantation: a comparative study. Eur J Ophthalmol. 2012 Jul-Aug;22(4):531-40. doi: 10.5301/ejo.5000090. PMID: 22139617
6. Khokhar, Sudarshan & Lohiya, Pavan & Vanathi, Murugesan & Panda, Anita. (2006). Corneal astigmatism correction with opposite

clear corneal incisions or single clear corneal incision: Comparative analysis. Journal of cataract and refractive surgery. 32. 1432-7. 10.1016/j.jcrs.2006.04.010.
7. Gross RH, Miller KM. Corneal astigmatism after phacoemulsification and lens implantation through unsutured scleral and corneal tunnel incisions. Am J Ophthalmol. 1996 Jan;121(1):57-64. doi: 10.1016/s0002-9394(14)70534-3. PMID: 8554081.
8. Budak K, Friedman NJ, Koch DD. Limbal relaxing incisions with cataract surgery. J Cataract Refract Surg. 1998 Apr;24(4):503-8. doi: 10.1016/s0886-3350(98)80292-7. PMID: 9584246.
9. Bayramlar H, Dağlioğlu MC, Borazan M. Limbal relaxing incisions for primary mixed astigmatism and mixed astigmatism after cataract surgery. J Cataract Refract Surg. 2003 Apr;29(4):723-8. doi: 10.1016/s0886-3350(02)01821-7. PMID: 12686239..
10. Kaufmann C, Peter J, Ooi K, Phipps S, Cooper P, Goggin M; Queen Elizabeth Astigmatism Study Group. Limbal relaxing incisions versus on-axis incisions to reduce corneal astigmatism at the time of cataract surgery. J Cataract Refract Surg. 2005 Dec;31(12):2261-5. doi: 10.1016/j.jcrs.2005.08.046. PMID: 16473215..
11. Carvalho MJ, Suzuki SH, Freitas LL, Branco BC, Schor P, Lima AL. Limbal relaxing incisions to correct corneal astigmatism during phacoemulsification. J Refract Surg. 2007 May;23(5):499-504. PMID: 17523513.
12. Gills JP, Rowsey JJ. Managing coupling in secondary astigmatic keratotomy. Int Ophthalmol Clin. 2003 Summer;43(3):29-41. doi: 10.1097/00004397-200343030-00004. PMID: 12881647.
13. Hayashi, Ken & Kondo, Hiroyuki & Yoshida, Motoaki & Manabe, Shin-ichi & Hirata, Akira. (2012). Higher-order aberrations and visual function in pseudophakic eyes with a toric intraocular lens. Journal of cataract and refractive surgery. 38. 1156-65. 10.1016/j.jcrs.2012.02.032..
14. Holland E, Lane S, Horn JD, Ernest P, Arleo R, Miller KM. The AcrySof Toric intraocular lens in subjects with cataracts and corneal astigmatism: a randomized, subject-masked, parallel-group, 1-year study. Ophthalmology. 2010 Nov; 117(11):2104-11. doi: 10.1016/j.ophtha.2010.07.033. Epub 2010 Sep 16. PMID: 20846724..

Conflict of interest: None

Funding: None

Cite this Article as: Sahare H, Murade S, Narote K, Kumar A, Rathod D. Study Of Change In Vision And Astigmatic Refractive Error Postoperatively In Patients Undergoing Clear Corneal Phacoemulsification Surgery With Foldable Intra Ocular Lens. Natl J Integr Res Med 2021; Vol.12(6): 20-25