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Original Research Article

Surgically Induced Astigmatism and Posterior Corneal Curvature Changes Following 2.2 and 2.8 mm Clear Corneal Incision in Phacoemulsification: A Comparative Study

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Abstract

Aim: To primarily compare surgically induced astigmatism (SIA), total and posterior corneal curvature, pachymetry, and their stabilization after 2.2 and 2.8 mm clear corneal incision in phacoemulsification.

Material & Method: This was a randomized, prospective interventional study enrolling 160 patients who were distributed randomly in group 1 (operated with 2.2 mm incision) and group 2 (operated with 2.8 mm incision) with 80 patients in each group.

Results: Mean SIA showed decrease from week 1 to week 6 in both the groups. The mean SIA in group 1 was lower than that in group 2 at all the follow-ups, although the difference was not statistically significant. There was no significant difference in K1 postoperatively as compared to preoperative value in both the groups' at all follow-up visits.

Conclusion: 2.2 mm incision induced a lesser amount of SIA as compared to 2.8 mm incision, although the difference was not statistically significant at all the follow-up visits.

Keywords: Cataract, phacoemulsification, superior approach, surgically induced astigmatism

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Introduction

As the refractive surface of the cornea is responsible for the major optical power of the eye, its surface has a crucial role in the optical function of the human visual system. This performance is outlined by the shape, regularity, clarity and refractive index of the cornea [1]. Therefore, changes in these elements can change the visual acuity.

Cataract is the most prevalent cause of reversible blindness worldwide. The only curative treatment of cataracts is surgical intervention and consists of replacing the cloudy lens by an intraocular lens (IOL) [2]. Cataract surgery may be performed by various techniques including phacoemulsification (PHACO) and extra capsular extraction [3]. The PHACO is the most used technique in cataract surgery in the world. It has the advantages of the smaller incision, less trauma to the eye, as well as shorter operation time and visual recovery [3].

Phacoemulsification technique can be used to minimize surgically induced astigmatism (SIA), which will produce

optimal postoperative vision. [4, 5]In addition, clear corneal incision (CCI) technique can further minimize SIA that was induced by surgical sutures.[6]

Surgically induced astigmatism (SIA) is defined as the flattening effect in that axis induced by an incision made on the cornea and influences the refractive outcomes of cataract surgery. SIA is influenced by preoperative astigmatism, incision size, location, architecture, corneal thickness, rigidity, and wound healing postoperatively.[4]

Thus, this study compares to compare and better understand the corneal topography, pachymetry changes, and SIA between 2.8 and 2.2 mm incisions among different cataract grades in phacoemulsification surgery.

Material & Method:

This was a randomized, prospective interventional study enrolling in Department of Ophthalmology Patna Medical College and Hospital, Patna, Bihar, India for 1 year. 160 patients who were distributed randomly in group 1 (operated with 2.2 mm incision) and group 2 (operated with 2.8 mm incision) with 80 patients in each group.

One-hundred sixty eyes of 160 patients of either sex having senile cataract (>40 years) graded as per Lens Opacities Classification System III (LOCS‑III) grading and divided into group 1 and group 2 by a computer-generated random number table. Patients in group 1 were operated with a 2.2 mm incision and in group 2 with a 2.8 mm incision.

Patients with preexisting conditions like pterygium grade II and III, corneal opacity, uveitis or other inflammatory eye diseases, complicated cataract, traumatic cataract, diabetic retinopathy, previous ocular surgery, and irregular astigmatism were excluded from the study.

The recruited patients were examined preoperatively and during follow-up at first, third, and sixth weeks postoperatively for uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA) with refraction. Corneal topography and pachymetry were evaluated using anterior segment analyzer-Pentacam (Oculus, Wetzlar, Germany). Intraocular lens (IOL) power was calculated using Lenstar 900 (Haag Streit Diagnostics, Koeniz, Switzerland). Preoperatively, +90D fundus examination and intraocular pressure measurement were done.

LOCS III was used for grading the cataract. The patients underwent uncomplicated phacoemulsification surgery with foldable IOL implantation using a 2.2 mm incision in group 1 and 2.8 mm incision in group 2 using the Oertli phacoemulsification system with the same technique. The primary outcome, SIA, was calculated using an online calculator available on doctor hill.com at first, third, and sixth weeks postoperatively.

Measurable values like age, sex, and LOCS III were considered qualitative or categorical variables and were described as percentages. The normality of the continuous data was tested using one Sample Kolmogorov–Smirnov test. The normally distributed data was tested using a paired t-test and the non normal data using Wilcoxon signed-rank test. Comparison across the two groups ‑ with 2.2 and 2.8 mm incision – was done using Mann–Whitney's test. The data analysis was done using the latest version 25 of IBM SPSS software (Statistical Product and Service Solutions).

Results:

Table 1 shows the variation of SIA in the two groups at different follow-ups. Mean SIA showed decrease from week 1 to week 6 in both the groups. The mean SIA in group 1 was lower than that in group 2 at

all the follow-ups, although the difference was not statistically significant [Fig. 1].

Also, when we compared SIA between the cataract grades, both the groups showed an increase in SIA with an increase in the hardness of the cataract at all the follow-ups [Table 2]. Although group 1 did show a decrease for the NS V cataract grade but given the small sample size of NS V grade cataracts (n = 1), the observations are not representative of the grade.

Table 3 lists the changes in total corneal curvature [K1, K2 (steep axis), and Astigmatism (ast)] and posterior corneal curvature [k1, k2, and astigmatism (ast)]. There was no significant difference in K1 postoperatively as compared to preoperative value in both the groups' at all follow-up visits.

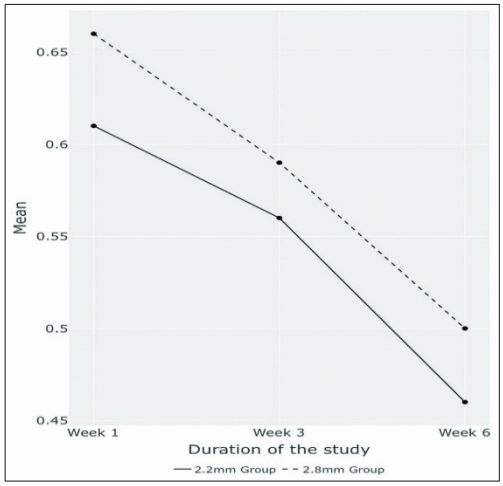

Figure 1: Trends of surgically induced astigmatism

Table 1: Mean surgically induced astigmatism (SIA)

Parameter	**Property**	**Week 1**	**Week 3**	**Week 6**
SIA				
Group 1	**Mean±SD**	0.77±0.29	0.51±0.2	0.50±0.27
Group 2	**Mean±SD**	0.70±0.32	0.56±0.5	0.44±0.31
P value		**0.621**	**0.863**	**0.271**

Table 2: Comparison of preoperative and postoperative total and posterior corneal curvature

LOCS-III Grade	Week 1		Week 3		Week 6	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
NS I	0.61 (±0.28)	0.61 (±0.09)	0.52 (±0.22)	0.41(±0.13)	0.48 (±0.25)	0.34 (±0.11)
NS II	0.63 (±0.30)	0.63 (±0.36)	0.53 (±0.31)	0.62 (±0.44)	0.51 (±0.19)	0.49 (±0.30)
NS III	0.70 (±0.42)	0.68 (±0.42)	0.54 (±0.28)	0.70 (±0.42)	0.63 (±0.29)	0.68 (±0.33)
NS IV	0.88 (±0.51)	0.72 (±0.28)	0.59 (±0.30)	0.74 (±0.16)	0.67 (±0.30)	0.68 (±0.33)
NS V	0.52 (±0.44)	0.75 (±0.40)	0.30 (±0.20)	0.80 (±0.41)	0.20 (±0.11)	0.66 (±0.40)

Table 3: Preoperative and postoperative total and posterior corneal curvature

	Parameter	Property	Preoperative	Week 1	Week 3	Week 6
K1	Group 1	Mean±SD	58.24±1.80	54.72±1.93	58.22±1.81	55.3±1.80
		p-value		0.621	0.692	0.292
	Group 2	Mean±SD	55.82±1.72	56.8±1.82	58.46±1.83	55.2±1.57
		p-value		0.281	0.822	0.480
K2	Group 1	Mean±SD	54.22±1.67	57.38±1.75	58.57±1.79	55.4±1.70
		p-value		0.582	0.272	0.001
	Group 2	Mean±SD	52.71±1.98	40.2±1.33	52.8±1.87	55.7±1.82
		p-value		0.723	0.005	< 0.001
AST	Group 1	Mean±SD	0.79±0.53	0.81±0.51	0.69±0.40	0.63±0.41
		p-value		0.621	0.681	0.040
	Group 2	Mean±SD	0.90±0.52	0.88±0.7	0.71±0.45	0.72±0.39
		p-value		0.201	0.001	< 0.001
k1	Group 1	Mean±SD	-7.14±0.44	-7.11±0.24	-7.12±0.27	-7.21±0.55
		p-value		0.011	0.562	0.371
	Group 2	Mean±SD	-7.63.±0.40	-7.26±0.41	-7.8±0.42	-7.27±0.42
		p-value		0.042	0.172	0.271
k2	Group 1	Mean±SD	-7.32±0.38	-7.51±0.47	-7.28±0.52	-7.26±0.46
		p-value		0.020	0.726	0.581
	Group 2	Mean±SD	-7.21±0.33	-7.60±0.40	-7.82±0.44	-7.30±0.40
		p-value		0.005	0.291	0.831
ast	Group 1	Mean±SD	-0.48±0.26	-0.47±0.30	-0.42±0.5	-0.42±0.39
		p-value		0.203	0.391	0.391
	Group 2	Mean±SD	-0.31±0.11	-0.39±0.21	-0.31±0.15	-0.39±0.19
		p-value		0.182	0.821	0.281

Discussion:

Phacoemulsification surgery with IOL implantation has become one of the safest, consistent and frequently performed surgery in ophthalmic practice leading to significant visual improvement. Any incision on cornea can potentially alter the optical power of the cornea. Reducing the incision size results in reducing the need for suturing, leading to more wound stability and a decrease in corneal aberrations.[7]

Publications demonstrated that cataract surgery may alter the biomechanical properties of the cornea and this change can be related to the size of surgical incisions [8]. Corneal incisions generally modify previous corneal astigmatism. This change is dependent on the size, shape and location of the incision [9]. The change of the corneal curvature is less when applying scleral incision, temporal location and a cut length less than 2 mm [10]. Only 2% of cataract surgeries are performed with micro incisions (< 2 mm), which are neutral for astigmatism, 66% of cataract surgeries are performed with incisions between 2.6 to 3.1 mm [11]. In our research, we used 2.75 mm incisions. The 2.75 mm incision generates a change of 0.65 D in the anterior curvature [12].

Getting accurate postoperative refraction will determine the success of cataract surgery.[13] One of the main factors that determine good postoperative refraction is SIA.[14]SIA is influenced by many factors, such as the type of cataract

surgery, incision type, incision site, and suturing techniques.[15]

Some hypotheses can be raised to justify our result. Collagen in the corneal surface and its viscoelasticity that is responsible for any aggression that may generate an elastic deformation is reversible by cessation of stress, returning to its original shape and volume [16] More keratocytes presented on the front surface than the back one can also justify the difference in results regarding variation of anterior and posterior corneal curvature after corneal incision [17].

Hashemi et al. in a study compared 2.2- and 2.8-mm incision groups by using vectoral analysis for SIA. They concluded that there were no clinical or statistically significant differences between the two techniques in minimizing the effect of incision size on SIA. This was similar to findings observed in our study.[18]

In a study by Schmitt AJ et al. [19] with 2.75 mm corneal incision where they have studied posterior corneal curvature changes, similar focal steepening was seen in both k1 and k2. These changes returned to preoperative values by 3 months and the differences were not statistically significant at any postoperative visit. In another study by Hayashi et al. [20] similar findings were observed. It was found that a focal steepening occurred in the posterior cornea around both the nasal and temporal CCIs of 2.4 mm and this wound‐related steepening rapidly diminished and was not detected at 4 weeks after surgery or later in either group.[21]

Conclusion:

2.2 mm incision induced a lesser amount of SIA as compared to 2.8 mm incision, although the difference was not statistically significant at all the follow‐up visits. The average SIA from the study was 0.34 diopter. Our study concludes that there is no statistically significant difference to SIA between three groups of astigmatism when they were operated using superior approach.

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