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Original Article

Change in Corneal Astigmatism After Phacoemulsification with Rigid Intraocular Lens Implantation

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ABSTRACT

Phacoemulsification with lens implant is the preferred method of cataract extraction nowadays. In resource-deficient settings, rigid polymethyl methacrylate (PMMA) lenses are implanted which require enlargement of corneal incision to 5.5mm. **Objectives:** We conducted this study to evaluate the effect of corneal incisions secured with a single suture on corneal astigmatism after routine cataract surgery. **Methods:** It was a quasi-experimental study conducted at tertiary care hospitals. Sixty patients were studied and preoperative visual acuity and keratometry readings were noted. After standard phacoemulsification, a 5.5mm rigid PMMA lens was implanted in the bag, and the corneal incision was sutured using a single central 10/0 nylon suture. Visual acuity and keratometry readings were noted on 1st postoperative day, 1-week postoperatively, and 6-weeks postoperatively and compared with pre-operative values. **Results:** The mean age was 59.27 ± 10.72 (range: 46 – 78) years. There were 32 (53.3%) males and 28 (46.7%) females in the study. The mean preoperative keratometry reading was 0.89 ± 0.70 D, and the mean first-day postoperative cylinder was 1.94 ± 0.98 D ($p < 0.05$). The mean astigmatism at the 6th week postoperatively was 0.96 ± 0.65 D, and its comparison with the pre-operative astigmatism was statistically not significant ($p > 0.05$). Surgically induced astigmatism was found to be 0.07 diopters. Almost 60% of the patients achieved uncorrected 6/7.5 or better visual acuity, and more than one-third of patients achieved 6/6 best corrected visual acuity six weeks after the cataract surgery using the described technique. **Conclusions:** Phacoemulsification with 5.5mm PMMA IOL with a central single suture is an effective procedure for postoperative astigmatism and visual outcome.

INTRODUCTION

Cataract is the most common cause of reversible blindness worldwide, so cataract extraction is perhaps the most efficient surgical procedure in all of the medicine [1]. In the last 15-20 years, with the use of sophisticated extracapsular cataract extraction (ECCE) and intraocular lens (IOL) implantation, a successful outcome of surgery is predictable [2]. However, the limiting factor in optimum postoperative visual function is often the amount of astigmatism. Surgically induced astigmatism can vary depending on the size and location of the incision, wound closure techniques, and suture material used. Astigmatism produces distortion caused by meridional magnification that may give rise to significant difficulties with binocular function. Every surgeon aims for minimum surgically induced astigmatism for the best visual outcome after cataract surgery [3-6]. Phacoemulsification has become the main surgical procedure of cataract extraction over the past two decades [6, 7]. It is one of the most innovative and popular techniques. It comprises a small incision size, less postoperative anterior chamber reaction, and less surgically induced astigmatism. Foldable lens implantation through a 3.5 mm to 4.0 mm incision significantly reduces postoperative astigmatism, but the main limitation of foldable IOL is their cost in developing countries especially in public hospitals [8].

This study aimed at determining the efficacy of phacoemulsification with implantation of a 5.5mm diameter polymethylmethacrylate (PMMA) intra-ocular

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lens with wound closure using a single central 10/0 nylon corneal suture.

METHODS

It was a quasi-experimental study conducted at the Department of Ophthalmology, Ameeruddin Medical College, Lahore General Hospital, Lahore and Department of Ophthalmology, Allama Iqbal Medical College, Jinnah Hospital Lahore from January 2023 to October 2023, after obtaining approval from the institutional ethical review board (ERB) of the same institution vide letter No. ERB/AIMC/203/102 dated 02/01/2023. Sixty patients were included in the study using consecutive non-probability sampling. We only included patients above 40 years of age presenting with senile cataracts. Patients with complicated cataracts, with a history of ocular surgery like pterygium excision, trabeculectomy, scleral buckling, corneal transplantation, or having other diseases like uveitis, keratoconus, glaucoma were excluded from the study. We got written informed consent from each study participant. Demographic information like name, age, and sex were recorded on a special proforma. Data was divided into pre-operative and postoperative variables. Preoperatively, a complete ophthalmic examination was performed. This included assessment of visual acuity using Snellen's chart, slit-lamp examination, intraocular pressure measurement using Goldman's applanation tonometer, dilated retinal examination, and keratometry readings using Topcon KR-8900 (Topcon Inc., Japan). The patients underwent a standard phacoemulsification procedure using Oertli Catarhex 3 (Oertli, Switzerland) phacoemulsifier. All the surgeries were performed by the same surgeon (SJ). Post-operative visual acuity, slit lamp examination, and keratometry readings were noted on 1st postoperative day, 1st week, and 6th week postoperatively. We analyzed the data using statistical software, SPSS version 23.0. Means were calculated for postoperative visual acuity and keratometry readings. The positive cases for astigmatism and the level of astigmatism were presented as proportions and categories. The gradient of astigmatism was assessed and reported as the level of variable change. A chi-square test was used for the presence of astigmatism and level of astigmatism, and a paired sample t-test was applied for pre- and post-operative visual acuity and keratometry readings. A p-value < 0.05 was taken as statistically significant.

RESULTS

This study was conducted on 60 cases. The mean age of the patients was 59.27 ± 9.72 (range: 46 – 78 years). There were 32 (53.3%) male patients and 28 (46.7%) female patients in the study (Table 1).

Table 1: Age distribution and pre-operative visual acuity of study population (N = 60).

Age (years)	Frequency (%)
40-50	17 (28.3)
51-60	19 (31.7)
61-70	20 (33.3)
71-80	4 (6.7)
Total	**60 (100)**
Mean ± SD	59.27 ± 10.72

The visual acuity of the study population is given in table 2. Almost 47% of the patients had hand motion or finger counting pre-operative visual acuity. At six weeks post-operatively, more than 58% of the patients achieved 6/7.5 or better visual acuity. After refraction, more than one-third of the patients were able to experience normal visual acuity of 6/6 in the operated eye.

Table 2: Comparison of pre-operative with uncorrected and best corrected visual acuity at 6-weeks after phacoemulsification.

Visual Acuity		Frequency (%)
Pre-Operative	6/18	2 (3.3)
	6/24 – 6/60	24 (40.0)
	5/60	4 (6.7)
	HM / CF	28 (46.7)
	PL +/ PR	2 (3.3)
Uncorrected	6/6	5 (8.3)
	6/7.5	35 (58.3)
	6/9	12 (20)
	6/12	6 (10)
	6/18	2 (3.4)
Best Corrected	6/6	40 (66.7)
	6/7.5	12 (20)
	6/9	5 (8.3)
	6/12	3 (5)
	6/18	0 (0)

HM: Hand motion
CF: Counting finger
PL+: Perception of light present
PR: Projection of light

The astigmatism was assessed from keratometry reading as shown in table 3. The mean ± SD preoperative cylinder was 0.89 ± 0.70 diopters cylinder (DC). whereas the mean post-operative astigmatism at 1st post-operative day, 1st post-operative week and 6th post-operative week was found to be 1.94± 0.98, 1.35± 0.84 and 0.96± 0.65 DC respectively. The difference in the preoperative and first and 7th post-operative day astigmatism was statistically

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significant ($p < 0.05$). However, the difference between the pre-operative and 6th-week post-operative keratometry readings was statistically not significant ($p > 0.05$).

Table 3: Comparison of pre-operative and post-operative diopter cylinder astigmatism after phacoemulsification.

	Pre-Operative	1st Post-operative Day (N=60)	1st Week Postoperative (N=60)	6th Week Postoperative (N=60)
Diopter Cylinder	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**
0.0-0.5	23 (38.3)	10 (16.7)	20 (33.3)	21 (35)
0.6-1.0	17 (28.3)	25 (41.7)	15 (25)	19 (31.7)
1.1-1.50	12 (20)	10 (16.7)	13 (21.7)	11 (18.3)
1.51-2.0	8 (13.4)	12 (20)	10 (16.7)	7 (11.7)
2.1-2.5	-	2 (3.3)	1 (1.6)	2 (3.3)
2.5-3.0	-	1 (1.6)	1 (1.6)	0 (0)
Mean	**0.89 ± 0.70**	**1.94 ± 0.98**	**1.35 ± 0.84**	**0.96 ± 0.65**

DISCUSSION

We report here the outcomes of corneal astigmatism after phacoemulsification with rigid intraocular lens implantation using a 5.5mm incision secured using a single suture. We observed significant change in the corneal astigmatism during the first week, however, the change in the post-operative and pre-operative astigmatism was not statistically significant at the end of 6 weeks after the surgery. This trend towards suture-less and small incision surgery results from continuous technical refinements aimed at reducing post-op astigmatism as well as the time necessary to achieve visual rehabilitation [9]. However, any incision above 3.5mm demands the application of corneal sutures to prevent leakage and the risk of exogenous infections in the early postoperative period. Therefore, securing the corneal wound with a single stitch using a 10/0 nylon suture is advised [1, 10]. Foldable IOL implantation is now an established trend for sutureless phacoemulsification as the smaller incisions significantly reduce post-op astigmatism. However, the main limitation of foldable IOLs is their cost in the developing world. That is why multitudes of extracapsular cataract extractions and phacoemulsification with rigid PMMA material are frequently performed in developing countries [8, 10, 11]. Other factors that need to be considered while using foldable IOLs include the lack of long-term follow-up of various materials and designs used for foldable IOLs compared to PMMA lenses and the risk of endothelial cell damage due to unfolding maneuvers [12]. Most surgeons such as Suhartini S et al., prefer using PMMA IOLs with a diameter of 5.5 mm in phacoemulsification through a limbal or scleral tunnel to minimize post-op astigmatism. However, this can compromise the vision by causing glare and unwanted images, especially under scotopic conditions or in the event of decentration [13]. In our study, phacoemulsification was performed through a 3.2 mm incision made temporally with a phaco-knife: in the right eye, phacoemulsification was done through a supertemporal incision and in the left eye through a super nasal incision. Wound enlargement up to 5.5mm was necessary to implant a 5.5mm optic of PMMA IOL. This PMMA IOL was implanted with the help of McPherson Forceps. The wound was closed with stromal hydration of the cornea and stitched in the center with a single 10/0 nylon suture. No attempt was made to alter the preoperative astigmatism during surgery. Analysis of the astigmatic cylinder was restricted to the keratometry cylinder. We observed higher post-operative astigmatic values in the early postoperative period. Mohan RR et al., and Liu L-R et al., explained this by alterations in the corneal biomechanics in the early postoperative period owing to surgical trauma in diffuse corneal edema, stroma edema, epithelial edema, and corneal wound burns [14, 15]. However, with time, the corneal healing mechanism restored the corneal anatomy, and we did not experience a statistically significant difference in the pre-operative and 6-week postoperative keratometry values. Another thing that should be considered is the operating surgeon's experience as shown by Pagano L et al. A tight stitch is bound to yield astigmatism postoperatively. However, an experienced surgeon can apply the stitch so that the change in corneal astigmatism is minimal, as seen in the results of our study [16]. Iftikhar S et al., conducted a similar study at Al-Shifa Trust Eye Hospital Rawalpindi and PIMS Islamabad [17]. They followed patients of phacoemulsification with implantation of 6 mm PMMA IOLs eight weeks postoperatively, and they found 53.7% had astigmatism of <1D, 30.5% had astigmatism of 1-1.5D and 14.81% had astigmatism >1.5D of which 5 had astigmatism <2D [17]. The level of postoperative astigmatism in our study compared favorably with the result of other studies of sutureless phacoemulsification with rigid PMMA IOLs of 6-7mm diameter [18–22]. We suggest future studies with longer follow-ups and measurement of keratometry readings using more advanced instruments like corneal topographers and taking into account pre- and postoperative change in the axis of astigmatism.

CONCLUSIONS

Removing cataracts through a 3.2mm limbal incision by phacoemulsification with necessary wound enlargement up to 5.5mm for PMMA IOL with one suture application is safe. The environment created within the eye during surgery is controlled and stable with minimal complications. The suture produces a very secure and stable wound with minimal leakage and much less chance

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of infection and inflammation. Phacoemulsification with PMMA IOL with a single suture wound closure produces satisfactory visual outcomes and an acceptable level of postoperative astigmatism, so this procedure can be used in poor populations who cannot purchase a foldable IOL.

Authors Contribution

Conceptualization: SJ
Methodology: SJ, MHA
Formal analysis: MHA
Writing-review and editing: UH, MHA, SJ

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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