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A Study of Paired Incision in Phacoemulsification Surgery

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Abstract: ***Purpose: To evaluate efficiency of paired incision in controlling corneal astigmatism in phacoemulsification surgery and assess the complications of these incision. Design: Prospective, Interventional (Non-Randomized) study. Methods: A total of 56 patients who required cataract surgery were selected as per inclusion and exclusion criteria. Routine phacoemulsification surgery was performed and a paired incision opposite to the main incision was made on the steeper meridian of cornea after intra ocular lens implantation. Post operative vision, refraction and keratometry difference was measured on week 1, month 1 and month 3. Data was then compared with pre-operative findings and difference in corneal astigmatism was observed. Results: Mean keratometry difference pre-operatively was 1.55+/-0.52 and post-operatively on week 1, month 1 and month 3 was 0.76+/-0.50, 0.55+/-0.40 and 0.50+/-0.39 respectively. There was significant reduction in corneal astigmatism in all the 3 follow up time interval when compared pre-operatively (P value <0.001). No incision related complication was observed. Conclusion: A simple paired incision applied opposite to the main incision on the steeper axis of cornea during phacoemulsification surgery is successful in improving pre-existing corneal astigmatism that is cheap and done without extra instrumentation and skills.***

Keywords: Keratometry, Astigmatism, Phacoemulsification, Paired incision

1. Introduction

Cataract surgery is one of the most commonly performed refractive surgery in the world. Advancements in technology and surgical techniques, on one hand, have ensured good post-operative outcomes, but have also, raised the patient's expectations, who now look forward to a near perfect spectacle free post-operative vision. In the age of refractive cataract surgery, addressing the patient's preexisting corneal astigmatism at the time of surgery is important for delivering postoperative emmetropia and satisfaction. Reducing postoperative astigmatism (no more than 0.50 to 0.75D) is principally vital for attaining optimal results with intraocular lenses (1).

Astigmatism is a common refractive error of eye that exists when the surface of the cornea or crystalline lens is shaped irregularly. It is a form of refractive error that can present alone or in combination with myopia or hyperopia. Its correction requires the use of cylinder lens power (2). The prevalence of preoperative astigmatism in cataract patients has been reported to be 86.6%, of which 35%–40% of the cataract patients have corneal astigmatism ≥1.0 D and 19%–22% have astigmatism ≥1.5 D (3). After the cataract surgery, correcting the residual astigmatism with a spectacle result in meridional magnification which can produce asymmetric and distorted retinal images thus reducing the spatial perception (4). Thus, it is better to correct the astigmatism in the corneal or intra-ocular lens place, during the cataract surgery itself to obtain the best outcomes.

Several options are present for the correction of astigmatism at the time of cataract surgery. These include incision placement on the steeper axis of corneal curvature, single or paired peripheral corneal relaxing incisions and toric IOL (Intra ocular lens) implantation. In phacoemulsification surgery the main incision placed on the steeper axis of corneal curvature is seen to correct small amounts of astigmatism that is sufficient for most patients. Larger amount of astigmatism can also be corrected by peripheral corneal relaxing incision (5). These include changing the incision size and location, corneal or limbal relaxing incision, clear corneal paired incisions at the steeper meridian and toric intraocular lenses implantation, also excimer lasers and femtosecond laser astigmatic keratotomy (1). This may be essential when multifocal intraocular lenses are implanted in eyes with more than 1 diopter of astigmatism.

All these methods have their own merits and demerits. The opposite clear corneal incision technique avoids the additive cost that is usually associated with toric intra-ocular lenses and the possible need to adjust the intra-ocular lens later. On the other hand, there are some concerns about the long-term durability of these incisions in keeping the astigmatism corrected (6).

Thus, this study was designed to evaluate the efficiency and complications of paired incision in controlling corneal astigmatism during phacoemulsification surgery.

2. Methods

The current research is an interventional prospective study that was carried out in the Ophthalmology Department of the Himalayan Institute of Medical Sciences (HIMS), located in Swami Ram Nagar, in the city of Dehradun, over the course of a year. All adult patients, between the age of 30-80years, presenting to the department of ophthalmology for evaluation and management of cataract were screened for inclusion.

Patients with keratometry difference between 1 and 3 diopters were included in this study, after obtaining written informed

consent. Those with oblique astigmatism, keratometry difference <1 diopter or >3 diopter, pre-existing corneal scars, keratoconus, previous ocular surgeries, past ocular trauma, subluxated cataractous lens or complicated cataract due to uveitis, glaucoma or other ocular pathologies were excluded.

All patients underwent detailed ophthalmic evaluation including visual acuity, refraction by dilated retinoscopy using eyedrop (Tropicamide 0.8% + Phenylephrine hydrochloride 5% w/v), slit lamp examination of anterior and posterior segments, measurement of axial length by A scan and measurement of corneal curvature both vertical and horizontal by manual keratometer. All included patients were then planned and taken up for phacoemulsification surgery. Intra-operatively, the main incision was applied on the steeper meridian of the cornea using 2.8mm disposable keratome ,once the intra ocular lens was implanted, the anterior chamber was filled by visco-elastic. Subsequently, an identical surgical incision was made opposite to the main incision and removal of visco-elastic was done and incisions were then hydrated.

Post-operatively, all patients were followed up and vision, refraction for astigmatism correction and keratometry difference was done at first week, first month and 3rd month after the surgery and post-operative incision related complications like Descemet's ripping, Descemet's tear, wound dehiscence or leak leading to flat anterior chamber if present, were recorded. All the data was documented and entered on a spread sheet in Microsoft Excel and the categorical data was presented as percentages and the continuous data was presented as mean and range. The pre-operative vision documented in Snellen's metric chart and Log MAR (minimum angle of resolution), refraction for astigmatism correction and keratometry difference was compared with post-operative findings at 1 week, 1 month and 3 months to ascertain the efficacy of the paired incision in controlling the corneal astigmatism. All analysis were made using SPSS (Statistical Package for Social Sciences) for windows version 24.0. The paired student T-test was used to conduct an analysis to compare the mean of two samples.

3. Results

A total of 56 patients underwent paired incision to control astigmatism during phacoemulsification surgery during the study period. The mean age of the study population was 62.8years (40 - 80years). The majority of patients were in the age group of 61-70 years that was 18 (32.1%). 31 patients were females (55.4%) whereas the rest 25 were males (44.6%). The left eye was operated in 24 patients (42.9%) and the right eye in 32 patients (57.1%).

Pre-operatively, the majority of the patients 16 (28.6%) had a vision of 6/60 (Log MAR 1.00) in the affected eye and astigmatism correction between 1.25 D – 1.75 D cylindrical lens in 33 patients (58.91%). That included 17 patients (30.35%) with against the rule (ATR) astigmatism and 16 patients (28.56%) having with the rule (WTR) astigmatism. Mean astigmatism correction was 1.48 +/- 0.49 D. The mean pre-operative keratometry difference was 1.55+/-0.52 D, with the majority between 1.00 – 1.25 D in 26 patients (46.4%).

1 patient developed endophthalmitis and was thoroughly managed and attained vision 6/12 by 3 weeks, was included in the study.

Highest number of cases had a vision of 6/9 (Log MAR 0.20) in 18 patients (32.1%) on week 1, 6/6 (Log MAR 0.00) in 19 patients (33.9%) on month 1 and 6/6 (Log MAR 0.00) in 26 patients (46.4%) on month 3 post-operatively. Table 1 gives a comparative measurement of vision in Snellen's metric and Log MAR chart pre-operatively, post-operatively on week 1, month 1 and month 3.

Majority of cases had refractive correction of less than or equal to 1 D cylindrical lens in 43 patients (76.78%) at 1-week, 48 patients (85.71%) at 1-month and 50 patients (89.29%) at 3-month post-surgery. Table 2 gives a comparative measure of refraction pre-operatively, post-operatively on week 1, month 1 and month 3. The spherical equivalence was excluded positive correction value at the respective axis was taken.

26 patients having pre operative keratometry difference between 1.00 – 1.25D were reduced to having a difference between 0.50 – 0.75 D (12) followed by 0.00-0.25 D (8) by week 1. However, 6 patients had the same difference after 1 week post operatively. Keratometry difference between 1.00 – 1.25 D further reduced from 19 patients in week 1 to 8 patients in month 1 post operatively. Among them 6 patients had keratometry difference left between 0.00 – 0.25 D and 5 patients were left with a difference between 0.50 – 0.75 D by month 1 post operatively. It was also observed that among the patients having keratometry difference 1.00 – 1.25 in month 1 postoperatively 7 remained constant and 1 had a difference between 0.00 – 0.25 D by month 3 post operatively. 10 patients (17.9%) had no corneal astigmatism by month 3. Table 3 depicts the keratometry difference pre-operatively, post-operatively on week 1, month 1 and month 3.

Mean astigmatism correction pre-operatively was 1.49+/-0.49D and on post-operative follow up visits was 0.77+/-0.45D, 0.87+/-0.48D and 0.96+/-0.51D on week 1, month 1 and month 3 respectively. Mean post-operative astigmatism correction at every visit was found to be significantly lower than mean pre-operative astigmatism correction ($p<0.001$). Similarly, Mean keratometry difference pre-operatively was 1.55+/-0.52D and on post-operative follow up visits was 0.76+/-0.50D, 0.55+/-0.40D and 0.50+/-0.39D on week 1, month 1 and month 3 respectively. Mean post-operative keratometry difference at every visit was found to be significantly lower than mean pre-operative keratometry difference ($p<0.001$) as shown in Table 4.

4. Discussion

In this prospective study, we evaluated the efficacy and complications of paired incision identical to the main incision using 2.8mm keratome during phacoemulsification surgery in controlling corneal astigmatism. Of the 56 patients included in our study, mean keratometry difference indicating corneal astigmatism was pre-operatively 1.55+/-0.52D and on post-operative follow up visits was 0.76+/-0.50D, 0.55+/-0.40D and 0.50+/-0.39D on week 1, month 1 and month 3

respectively. This difference was statistically significant at all follow up visits (p<0.001).

In the study conducted by J Lever et al (June 2000) by using opposite clear corneal incision (OCCI) to reduce corneal astigmatism. 2.8 to 3.5 mm keratome were used in 33 eyes in 26 patients with pre-existing astigmatism (PEA) greater than 2.00 dioptres (D) were selected in 12 months. The mean PEA was 2.81+/-0.74D (range 2.00 to 5.00 D) and the postoperative astigmatism, 0.75+/-0.60 D (range plano to 1.75 D) (6). This study shows statistically significant reduction in corneal astigmatism that is similar to the current study. An opposite corneal incision as well as paired incision is self-sealing, give minimum surgically induced astigmatism and have a better flattening effect of the steeper meridian of cornea, thereby reducing corneal astigmatism.

In another the study conducted by Sudarshan Khokhar et al (September 2006) where 40 eyes of 40 patients with topographic astigmatism of more than 1.50 diopters (D) were selected. Paired 3.2 mm OCCIs were made in the steep axis in Group 1 and single clear corneal incision in Group 2. Twelve weeks postoperatively, the mean preoperative and postoperative topographic corneal astigmatism was 2.51+/-0.92 D and 0.91+/-0.54 D, respectively, in Group 1 and 2.17+/-0.81 D and 1.57+/-0.70 D, respectively, in Group 2 (both P= 0.00) (7) This shows that reduction in corneal astigmatism can significantly be achieved by modification in incision in phacoemulsification surgery. OCCI and SCCI give significant reduction in corneal astigmatism, OCCI or a simple paired incision give relatively better outcome.

In our study, it was also observed that a significant reduction was observed in corneal astigmatism post operatively on week 1, month 1 and month 3, however this difference was not significant when the findings of month 1 or month 3 were compared with week 1. This depicts that the severity of astigmatism has minimum change in longer duration.

Similarly observed in another study conducted by Nazanin Binayi Faal et al (January 2022), 64 eyes of 55 patients with keratometry astigmatism of ≥ 1 diopter (D) undergoing phacoemulsification were selected. Initial incisions were performed on the temporal side with 3.2 mm keratome and paired stab incisions were performed on the steep meridian. It was found that the mean preoperative keratometry astigmatism was 2.06 ± 0.86 D. The postoperative mean keratometry astigmatism was 1.3 ± 0.7 D after 1 month and 1.2 ± 0.7 D after 12 months. The mean astigmatism correction between the preoperative measure and that taken at 1 month was statistically significant ($P = 0.001$), but there was no significant change in the severity of astigmatism afterward (8).

Our study also relates keratometry difference with astigmatism correction using spectacles where the outcomes are comparable. Mean astigmatism correction pre-operatively was 1.49+/-0.49D and on post-operative follow up visits was 0.77+/-0.45D, 0.87+/-0.48D and 0.96+/-0.51D on week 1, month 1 and month 3 respectively. Mean post-operative astigmatism correction at every visit was found to be significantly lower than mean pre-operative astigmatism correction (p<0.001). Not many studies have been performed taking cylindrical correction as a parameter for astigmatism improvement.

A simple step of paired incision undertaken in the conventional method of phacoemulsification, no extra instrumentation is required in recording the parameters and is economically better. This makes simple procedures that are incision based during cataract surgery superior to the expensive toric lenses. As shown in a study conducted by Giuliano Oliveira Freitas et al (2014) where toric lens was used to reduce corneal astigmatism, pre-operative mean topographic corneal astigmatism was 1.41 ± 0.54D and post-operative was 0.58 ± 0.24D, 0.63 ± 0.20D and 0.62 ± 0.17 on month 1, month 3 and month 6 respectively (9). The outcome is similar to our study with an advantage of having no added expense.

Limitations observed in our study are that less number of sample cases collected in a limited period. The type of intraocular lenses and their influence over astigmatism were not recorded. Single mode of method (paired incision) applied and comparison between other methods (toric lenses, limbal relaxing incision) were not done. Oblique astigmatism was not included.

5. Conclusion

In the current study it can be concluded that a simple paired incision applied opposite to the main incision on the steeper axis of cornea in phacoemulsification surgery can easily improve corneal astigmatism without any extra skill or instrumentation. This can limit the spectacle use and provide patient satisfaction in a cost-effective manner.

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Table 1: Vision assessment in Snellen's metric chart and Log MAR at 4 meters for vision better than 6/60 and Log MAR at 1 meter beyond 6/60 of the study population at pre-operative, 1 week, 1 month and 3 months after the surgery.

Vision in Snellen's metric chart (Log MAR)	Pre-operative Number of cases (percentage %)	1 week post-op Number of cases (percentage %)	1 month post-op Number of cases (percentage %)	3 month post-op Number of cases (percentage %)
6/6 (0.00)	0	10 (17.9)	19 (33.9)	26 (46.4)
6/9 (0.18)	4 (7.1)	18 (32.1)	18 (32.1)	14 (25)
6/12 (0.30)	7 (12.5)	11 (19.6)	10 (7.9)	10 (17.9)
6/18 (0.48)	1 (1.8)	6 (10.7)	4 (7.1)	3 (5.4)
6/24 (0.60)	8 (14.3)	4 (7.1)	3 (5.4)	3 (5.4)
6/36 (0.78)	5 (8.9)	3 (5.4)	1 (1.8)	0
6/60 (1.00)	16 (28.6)	2 (3.6)	0	0
FC at 5 meters (1.08)	2 (3.6)	1 (1.8)	1 (1.8)	0
FC at 3 meters (1.18)	4 (7.1)	0	0	0
FC at 2 meters (1.48)	3 (5.4)	0	0	0
FC at 1 meter (1.80)	5 (8.9)	1 (1.8)	0	0
HMCF (3)	1 (1.8)	0	0	0

FC- Finger counting
HMCF- Hand movement close to face

Table 2: Refraction of the study population at pre-operative, 1 week, 1 month and 3 months after the surgery

Refraction in operated eye	Total Patients (%)			
	Preoperative	Week 1	Month 1	Month 3
Less than or equal to 1D	11 (19.65)	43 (76.78)	48 (85.71)	50 (89.29)
1.25 D – 1.75 D	33 (58.91)	11 (19.65)	7 (12.50)	6 (10.71)
2 D – 2.75 D	11 (19.65)	2 (3.58)	1 (1.79)	0
NO ACCEPTANCE	1 (1.79)	0	0	0

Table 3: Keratometry difference of the study population at pre-operative, 1 week, 1 month and 3 months after the surgery

Keratometry difference (D)	Number of patients Percentage (%) pre-operatively	Number of patients Percentage (%) week 1	Number of patients Percentage (%) month 1	Number of patients Percentage (%) month 3
0.00 – 0.25	0	13(23.2)	19(33.9)	22(39.3)
0.50 – 0.75	0	17(30.4)	25(44.6)	23(41.0)
1.00 – 1.25	26(46.4)	19(33.9)	8(14.3)	8(14.3)
1.50 – 1.75	12(21.5)	5(8.9)	3(5.4)	2(3.6)
2.00 – 2.25	13(23.2)	1(1.8)	0	0
>/=2.50	5(8.9)	0	0	0
Could not be assessed	0	1(1.8)	1(1.8)	1(1.8)

Table 4: The mean refraction correction and keratometry difference in the operated eye, pre-operatively, 1week, 1month, 3months post-operatively

Parameter	Pre-operative	1-week post-operative	1-month post-operative	3-month post-operative	P value
Mean astigmatism correction (mean +/-SD)	1.48+/-0.49	0.77+/-0.45	0.87+/-0.48	0.96+/-0.51	Pre-op vs 1 week- <0.001 Pre-op vs 1 month - <0.001 Pre-op vs 3 months- <0.001
Mean keratometry difference (mean +/- SD)	1.55+/-0.52	0.76+/-0.50	0.55+/-0.40	0.50+/-0.39	Pre-op vs 1 week - <0.001 Pre-op vs 1 month - <0.001 Pre-op vs 3 month - <0.001 1week vs 1 month - <0.001 1 month vs 3 month - 0.07