Evaluation of Opposite Clear Corneal Incision in Controlling Astigmatism in Cataract Patients Undergoing Phacoemulsification Surgery

J.S. Bhalla, Meenakshi Rani, Surbhi Gupta
Department of Ophthalmology, Deen Dayal Upadhyay Hospital, New Delhi, India

Abstract

Aim: To evaluate the role of clear corneal incision combined with opposite clear corneal incision in controlling astigmatism in patients undergoing phacoemulsification surgery for cataract.

Design: Prospective clinical study.

Methods: 45 consecutive patients planned for phacoemulsification were divided into three equal groups of fifteen patients each: Group 1 presenting without corneal astigmatism, Group 2 having WTR (with-the-rule) and Group 3 having ATR (against-the-rule) astigmatism. All underwent phacoemulsification through 2.8mm clear corneal incision. In Group 1 the temporal clear corneal incision (CCI) was enlarged to 3.2mm before IOL insertion along with 2.2mm superior CCI to neutralise the astigmatism induced by main cataract incision. In Group 2 the superior CCI was enlarged to 3.2mm before IOL insertion, followed by 3.2mm inferior opposite CCI. In Group 3 the temporal CCI was enlarged to 3.2mm before IOL insertion followed by 3.2mm nasal opposite CCI.

Results: In Group 1, the overall mean postoperative astigmatism observed was 0.28 ± 0.2D WTR, with 4 out of 15 patients (26.66%) continuing to have nil astigmatism. In Group 2, the mean postoperative astigmatism was reduced from 1.16 ± 0.32D WTR preoperatively, to 0.46 ± 0.28D WTR at 3 months postoperatively. In Group 3, the preoperative astigmatism of -1.25 ± 0.32D ATR reduced to -0.38 ± 0.31D ATR, 3 months postoperatively. The reduction in astigmatism was statistically significant in both WTR and ATR astigmatism groups (p < 0.001).

Conclusion: More than 50% reduction in astigmatism was achieved in both groups with astigmatism. Thus opposite clear corneal incision (OCCI) is a simple, predictable, safe and effective procedure in reducing mild to moderate preexisting corneal astigmatism in cataract surgery.

Keywords: clear corneal, astigmatism, cataract, phacoemulsification, OCCI

Introduction

It is estimated that approximately 70% of the general population has at least 1.00D of astigmatism and approximately 33% of patients undergoing cataract surgery are eligible for treatment of preexisting astigmatism. Not correcting the astigmatic component at the time of cataract surgery will thus fail to achieve spectacle independence. A simple manipulation of incision parameters (size, location and shape) enables the surgeons to tailor their astigmatic outcome. Location of the incision is an important factor, since corneal incisions lead to flattening of incised meridian. There is enhancement and additive flattening effect of two clear corneal incisions as compared to one incision on steep axis or Limbal Relaxing Incisions (LRI). Toric IOLs have limitations in terms of cost, possibility of rotation and under correction in cases of ATR astigmatism. There are very few studies predicting the role of opposite clear corneal incision (OCCI) as an effective measure to correct mild to moderate pre-existing astigmatism. Our study is aimed at evaluating the efficacy of OCCI, which is a simple and easy to learn method, without any additional cost.

Materials and Methods

This prospective clinical study included 45 patients between 50 and 70 years, (at DDU Hospital, New Delhi) with senile cataract, planned for clear corneal phacoemulsification with PCIOL (posterior chamber intraocular lens) implantation, from November 2013 to June 2014. All surgeries were performed by a single experienced surgeon (JSB) and informed written consent was taken from each patient for inclusion in the study.

Inclusion criteria:
- Senile cataract (< grade 4) with fitness for surgery
- Preexisting regular astigmatism, ≥1.0 D but < 3.0 D for groups 2 and 3
- Zero preexisting astigmatism for group 1

Exclusion criteria:
- Traumatic or complicated cataract
- Endothelial density <2000 cell/mm², corneal degeneration or opacities
- Any other ocular disease/surgery, underlying collagen vascular disease

Preoperatively, visual acuity assessment, slit lamp biomicroscopy, fundus examination, keratometry, axial length and IOL power calculation of all patients was done.
The patients were divided into three groups depending upon pre-existing astigmatism. All patients underwent 2.8mm clear corneal phacoemulsification with PCIOL implantation.

**Group 1** comprised of 15 patients having no preoperative astigmatism. The temporal clear corneal incision (CCI) was enlarged to 3.2mm before IOL (intraocular lens) insertion along with 2.2mm superior CCI to neutralize the astigmatism induced by main cataract incision.

**Group 2** comprised of 15 patients having with-the-rule (WTR) astigmatism. The superior CCI was enlarged to 3.2mm before IOL insertion followed by 3.2mm inferior opposite CCI. (Astigmatism “with the rule” refers to the axis of the plus cylinder standing more or less vertical (75° to 105°)).

**Group 3** comprised of 15 patients having preoperative against-the-rule (ATR) astigmatism. The temporal CCI was enlarged to 3.2mm at the time of IOL insertion followed by 3.2mm nasal opposite CCI. (“Against the rule” means the plus cylinder axis lies relatively horizontal (165° to 15°)).

There were no intra-operative or post-operative complications and no patients were lost to follow-up. Patients were followed postoperatively on day 1, day 7, 1 month and 3 months. Astigmatism, visual acuity (aided and unaided) and keratometry was recorded at 1 and 3 months. Refraction was performed at 3 months in all cases to record the Best corrected visual acuity (BCVA). The surgically induced astigmatism (SIA) was calculated by the method as described by Holladay et al using online calculator for SIA calculation. The preoperative and postoperative astigmatism was calculated using the corneal curvature readings (measured by Auto Ref keratometer, GR-3100K, Grand Seiko, Co. Ltd).

The results were statistically analyzed by using Student t-test (paired and unpaired) and Chi-square test. A p value of <0.05 was taken as statistically significant.

**Observations And Results**

| Time Duration | Group 1 | Group 2 | Group 3 |
|---------------|---------|---------|---------|
| Preoperative  | 1.16 ± 0.32D (Mean axis was 89.07 ± 1.94 degrees) | 1.25 ± 0.32D (Mean axis was 1.67 ± 44.89 degrees) |
| Day 1         | 0.5 ± 0.25 (107.2 ± 37.19) | 0.38 ± 0.35 (83.2 ± 62.67) | 0.3 ± 0.36 (83.66 ± 86.11) |
| Day 7         | 0.4 ± 0.18 (107.1 ± 37.07) | 0.33 ± 0.26 (89.13 ± 58.51) | 0.41 ± 0.33 (131.3 ± 66.83) |
| 1 Months      | 0.33 ± 0.22 (83.07 ± 52.86) | 0.46 ± 0.26 (100.7 ± 46.88) | 0.4 ± 0.32 (137.7 ± 74.89) |
| 3 Months      | 0.28 ± 0.20 (77.07 ± 56.97) | 0.46 ± 0.28 (82.53 ± 41.05) | 0.38 ± 0.31 (137.7 ± 74.85) |

There was no statistically significant difference in the surgically induced astigmatism at 1 month and 3 months in any of the groups. Figure 1 shows the postoperative keratometric values at 3 months in all the patients. The mean surgically induced astigmatism (SIA) in group 1 at 1 month and 3 months was 0.33 ± 0.22D WTR and 0.3 ± 0.21D WTR respectively. In group 2, the mean SIA was 0.76 ± 0.34D ATR at 1 month and 0.70 ± 0.28D ATR at 3 months. The surgically induced astigmatism in group 3 at 1 month and 3 months was 0.91 ± 0.32D WTR and 0.90 ± 0.29 D WTR respectively. There was a statistically significant difference in the SIA at 3 months between group 1 and group 2, and between groups 1 and 3. SIA of group 2 and group 3 was not statistically different.

**Figure 1:** Graph showing postoperative keratometric values (in Diopters) at 3 months.
comparable (p>0.05). There was no statistically significant difference between SIA at 1 month vs SIA at 3 months in the three groups (p=0.88 in group 1, p=1 in group 2 and p=0.751 in group 3). (Figure 2)

At 3 months postoperatively, 7 out of 15 patients in groups 1 and 3 each, had an uncorrected visual acuity (UCVA) of 6/9 - 6/9p, while in group 2, 8 patients had a UCVA of 6/6 - 6/6p. Of the total 45 patients, 17 (37.77%) had a UCVA of 6/6 - 6/6p, followed by 6/9 - 6/9p, which was attained in 16 (35.55%) patients.

93.32% in group 1, 79.99% in group 2, and 93.32% in group 3, had VA > 6/12p, the difference between groups being statistically insignificant (p = 0.407). Thirty-three out of 45 eyes (73.33%) had a best corrected visual acuity (BCVA) of 6/6 at 3 months, while one patient had a BCVA of 6/6p. This was followed by 9 (20 %) patients who had a BCVA of 6/9. Two (4.44%) patients had a BCVA of 6/12, because of presence of age related macular degeneration.

Discussion

Astigmatism is a major cause of sub-optimal visual outcome after cataract surgery. Thus, several techniques to manage preexisting astigmatism during cataract surgery have been developed, aiming to achieve emmetropia and eliminate spectacle dependence. Although astigmatism can be surgically corrected even after the cataract surgery, it is more appropriate to combine the two procedures. Preexisting corneal astigmatism at the time of cataract surgery can be treated by manipulation of cataract incision, limbal relaxing incision, astigmatic keratotomy or implantation of toric intraocular lenses. The astigmatic modifying effect of the cataract incision site, size, shape is well documented. Arcuate keratotomy needs diamond knife, corneal marker, pachymeter and nomogram. Arcuate incisions 6 to 7 mm in length, 80 to 90% corneal thickness are performed on the steep axis, leading to corneal flattening. However, arcuate keratotomy near the limbus (limbal relaxing incision i.e. LRI), heals quickly, leaving minimal astigmatic corrective effect and if it is away from limbus (corneal relaxing incision i.e. CRI), it results in unstable refraction in the long term along with problems of glare, foreign body sensation and halos.

Toric intraocular lens implantation results in predictable results, but the lenses are expensive and the learning curve is steep. Decentration is the main complication (10 to 15% of patients). Excimer laser can be used postoperatively to correct preexisting astigmatism in cataract patients but it is expensive and requires a refractive surgeon. Also, complications such as loss of BCVA, a decentered zone, flap complications, difficult night vision etc. must be kept in mind.

Opposite clear corneal incision (OCCI), in contrast, is a relatively simple technique requiring no extra instrumentation and can be done in routine settings, but may be difficult with certain axes. Lever and Dahan were the first ophthalmologists to introduce OCCI surgical technique in the year 2000. They found that a CCI has a small flattening effect on corneal curvature due to formation of scar tissue where tissue has been separated by incision, which can be used to reduce pre-existing astigmatism. Paired OCCIs have an enhanced effect and produce a stable flattening effect over the long term. The amount of correction varies, but is usually reported to be less than 1.2D with single 3.2 mm incision. So wider incisions or an additional incision have been advocated in cases with higher astigmatism. Flattening induced by 3.2mm is more compared to smaller incisions, therefore most studies have used 3.2 mm incision in OCCI. Clear corneal incisions are invasive and produce a stable flattening effect over the long term. OCCIs have an enhanced effect and are self-sealing. WTR astigmatism induced by temporal CCI in cases with nil pre existing astigmatism is minimal usually about 0.25-0.75 D hence only small superior CCI of 2.2 mm is sufficient to tackle it. The mean surgically induced astigmatism in patients with smaller incisions was significantly less than in patients with 3.0-mm incisions.

In group 1, 4 out of 15 patients (26.66%), continued to have 0 astigmatism while 9 (60%) had WTR astigmatism and 2 (13.33 %) had ATR astigmatism at 3 months. The overall mean postoperative astigmatism observed was 0.28 ± 0.2D WTR, which being less than 0.5D is clinically negligible. Thus, OCCI is effective in neutralizing the surgically induced astigmatism after phacoemulsification surgery in patients with nil preoperative astigmatism. In the present study, in group 2, the mean astigmatism was reduced from 1.16 ± 0.32D WTR preoperatively to 0.46 ± 0.28 WTR at 3 months postoperatively. Khokhar et al, in 2006 reported that...
mean reduction in corneal astigmatism was 0.85 ± 0.75D and mean SIA measured by vector-corrected method was 0.85 ± 0.75D. 12 weeks postoperatively in patients undergoing phacoemulsification by 3.2mm clear corneal incision on steep axis i.e. on-axis incision. Tadros et al showed that the mean reduction in the corneal astigmatism was 0.5D and the mean SIA was 1.57D in patients undergoing on-axis clear corneal cataract incision and opposite clear corneal incisions in phaco emulsification. The results of our study are thus comparable to these studies. In another study by Bazzazi et al, the mean preoperative corneal astigmatism in the group of patients with > 1D WTR astigmatism undergoing phacoemulsification with superior incision and an opposite clear corneal incision was 1.82 ± 0.86D WTR which was decreased to 1.31 ± 0.59D WTR postoperatively. The induced astigmatism was -0.50 ± 0.79D ATR.

In group 3, the preoperati
gastigmatism of -1.25 ± 0.32D ATR was reduced to -0.38 ± 0.31D ATR 3 months postoperatively, in our study. Six (24%) patients converted to WTR astigmatism, 16 (64%) patients continued to have ATR astigmatism and 3 (12%) had nil astigmatism. In a study by Bazzazi et al, the mean preoperative astigmatism was -1.74 ± 0.86D ATR. At 3 months postoperatively the mean postoperative astigmatism was -1.19 ± 0.64D ATR. The mean SIA at 3 months postoperatively was 0.55 ± 0.68D WTR. The results obtained in the current study are thus comparable. Another study by Qummar and Mullaney evaluated the astigmatic correction effect of opposite clear corneal incision on the steep corneal meridian in patients with topographic astigmatism of >2D. The mean astigmatic correction was 1.23 ± 0.49D and mean surgically induced astigmatism was 1.31 ± 0.59D WTR postoperatively. The induced astigmatism was -0.50 ± 0.79D ATR. Hence, our study shows comparable results to the above mentioned study. In earlier studies of OCCIs the mean reduction in corneal astigmatism ranged from 0.50 to 2.06D. We could achieve a decrease in corneal astigmatism of 1.50D in patients with ATR, 1.30D in patients with WTR, with OCCIs. Others have reported mean SIA of 0.55D, 2.25D, 1.60D 1.75D and 2.10D. An accurate comparison with these studies is not possible due to varying incision lengths, site, type, and magnitude of astigmatism. The disadvantages of Opposite clear corneal incisions (OCCIs) include under-correction or overcorrection, theoretical risk of endophthalmitis from penetrating incision compared with non-penetrating techniques, wound leak, difficulty to the surgeon in moving the site of phacoemulsification in response to variation in astigmatic axis, possible weakening of integrity of globe, inability to correct higher degrees of astigmatism. No major complication was seen in any of our cases. Further, young patients heal differently than older patients and the effect of OCCI is not expected to be uniform in all age groups. The lacunae of this study are shorter follow ups, with a small range of astigmatism and a limited sample size.

Conclusion

Opposite clear corneal incisions (OCCIs) is a simple, predictable, successful, easy to learn, safe and cost effective procedure in reducing mild to moderate preexisting corneal astigmatism in cataract surgery.

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**Corresponding author:**

JS Bhalla

MS, DNB

Consultant, Department of Ophthalmology,

Deen Dayal Upadhyay Hospital, New Delhi 110064

Email: jsb2159@gmail.com