Opposite Clear Corneal Incisions versus Steep Meridian Incision Phacoemulsification for Correction of Pre-existing Astigmatism

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Purpose: To compare the efficacy of adding an opposite clear corneal incision (OCCI) on the steep meridian versus performing surgery on the steep meridian alone during phacoemulsification in reducing pre-existing corneal astigmatism.

Methods: This randomized clinical trial was performed on 120 eyes with corneal astigmatism of >1D undergoing phacoemulsification. Incisions were made based on the type of astigmatism as follows: superior or superior+OCCI for with-the-rule and temporal or temporal+OCCI for against-the-rule astigmatism. Patients were followed with refraction, keratometry and topography. Statistical analysis was performed using one- and two-way ANOVA and Tukey-a test.

Results: Mean corneal astigmatism was 1.82±0.86 D in the superior+OCCI group and 1.74±0.86 D in the temporal+OCCI group preoperatively which decreased to 1.31±0.59 (P=0.013) and 1.19±0.64 (P=0.009) postoperatively respectively. No significant change occurred in the amount of astigmatism in any of the two single incision groups.

Conclusion: Paired OCCI on the steep axis is a useful technique to correct mild to moderate pre-existing astigmatism with no need for particular skill or additional instruments.

J Ophthalmic Vis Res 2008; 3 (2): 87-90.

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Received: February 2, 2008 **Accepted:** May 6, 2008

INTRODUCTION

Astigmatism may cause blurred vision, glare sensation, monocular diplopia, asthenopia and visual aberrations.[1] Correction of astigmatism is one of the main purposes of modern cataract surgery; this has resulted in a shift toward small incision surgery using foldable intraocular lenses (IOLs).[2] Several methods have been employed for this purpose including changing the size and site of the incision,[3] using corneal or limbal relaxing incisions,[4] applying opposite clear corneal incision (OCCI) on the steep axis,[5] implantation of toric IOLs[6,7] and laser in situ keratomileusis (LASIK).[8] The aim of all the above-mentioned measures is to achieve acceptable uncorrected visual acuity (UCVA) and improve patient satisfaction.

Lever and Dahan[5] were the first to apply a pair of OCCI on the steep axis to correct pre-existing astigmatism during cataract surgery. This method does not require additional skill or instruments. In this study we evaluated the efficacy of adding an OCCI on the steep axis of the cornea during phacoemulsification in order to reduce pre-existing corneal astigmatism.

METHODS

This randomized clinical trial was conducted on patients with senile cataracts and corneal astigmatism greater than 1 diopter (D). Based on the axis of the cylindrical component of refractive error according to keratometric (topographic) reading, superior (for with-the-rule astigmatism) or temporal (for against-the-rule astigmatism) corneal incisions were made. Within each study group patients were randomly assigned to applying an additional OCCI or not. Therefore the study consisted of four groups including superior incision, superior incision+OCCI, temporal incision and temporal incision+OCCI.

Patients with history of previous anterior segment procedures, corneal trauma or irregular astigmatism were excluded. Preoperative examinations included UCVA, refraction, best-corrected visual acuity (BCVA), slitlamp biomicroscopy, funduscopy, tonometry, keratometry and topography.

The steep corneal axis was marked preoperatively with the patient in sitting position. Clear corneal incision was made 1 mm anterior to the limbus on the steep axis using a slit-angled 3.2 mm disposable keratome (Mani Ophthalmic, Tochivi, Japan). Standard phacoemulsification was performed using two stab wounds for performing capsulorrhexis and insertion of the second instrument. Methylcellulose was used in all subjects and the same type of foldable IOL (Kontur GmBH, Boehringer, Germany) was implanted. After irrigation of the anterior chamber, the eye was formed using balanced salt solution and any leakage from the incisions was controlled using stromal hydration. The opposite clear corneal incision was made on the opposite steep axis using the same knife after viscoelastic injection. All operations were performed by one surgeon (N.B.) and all patients received chloramphenicol (every 4 hr for 1 week) and batamethasone (every 3 hr for 2 weeks which was tapered and discontinued over 2 weeks later) eye drops postoperatively. Patients received artificial tears thereafter if needed.

Follow-up visits were scheduled 1 day, 1 week, and 1 and 3 months postoperatively which included slitlamp biomicroscopy, tonometry, refraction and keratometry. Corneal topography was obtained at final follow-up for all subjects. Jaffe vector analysis was used for comparing pre- and postoperative stigmatism. The results were analysed using one- and two-way analysis of variances (ANOVA) and Tukey-a complementary test with significance level set at 0.05. Tukey-a test is used in conjunction with ANOVA when the difference among more than 2 groups is significant according to ANOVA in order to find which mean is significantly different from the other.

RESULTS

Overall 120 eyes of 120 patients including 68 (56.7%) female and 52 (43.3%) male subjects with mean age of 64.6±9.2 (range 52-85) years were enrolled in the study. The 4 study groups did not differ significantly in terms of age (data not presented). Table 1 summarizes pre- and postoperative astigmatism in the study groups. One-way ANOVA revealed that the 4 groups did not significantly differ in terms of preoperative astigmatism; however postoperative and induced astigmatism was significantly different among them. Two-way ANOVA demonstrated that adding OCCI ($P<0.001$) is effective in reducing astigmatism whereas the type of corneal incision (superior versus temporal) is not ($P=0.71$). Moreover, the interaction between addition of OCCI and the type of corneal incision had no statistically significant effect in this regard ($P=0.93$).

Table 1 Mean astigmatism in the study groups

Study groups	Mean astigmatism		
	Pre-op	Post-op	Induced
Superior	1.999±0.84	1.996±0.81	0.003±0.47
Superior+OCCI	1.824±0.86	1.319±0.59	0.505±0.79
Temporal	1.643±0.65	1.607±0.68	0.036±0.51
Temporal+OCCI	1.748±0.82	1.191±0.64	0.557±0.68
P value*	0.37	<0.001	0.001

op, operation; OCCI, opposite clear corneal incision.
*one-way analysis of variance.

Tukey-a complementary test demonstrated that the observed differences in postoperative induced astigmatism were statistically significant in temporal incision vs temporal incision+ OCCI (P=0.009) and superior incision vs superior incision+OCCI (P=0.013).

DISCUSSION

Patients undergoing cataract surgery expect clear vision and less dependence on spectacles. To attain this goal, one important consideration is reduction of astigmatism. Modern cataract surgery using small incisions and foldable IOLs has led to achieving emmetropia in a great number of patients.[1,9] Modifications in surgical technique and incisions may further improve refractive outcomes by reduction of astigmatism.

Different methods have been used to correct pre-existing astigmatism during cataract surgery. Making the incision on the steep corneal axis is the simplest method but may be difficult or impossible with certain axes. The amount of correction using this method varies but is usually reported to be less than 1D.[10] Astigmatic keratotomy, is another alternative which entails drawbacks such as glare sensation, diplopia and fluctuation of refractive error due to proximity of the incisions to the center cornea. In addition, it requires preoperative pachymetry and use of a diamond knife.[11] Corneal relaxing incisions are another method for correction of pre-existing corneal astigmatism; advantages include being technically easy, producing less symptoms, earlier wound stabilization due to the location of the incision and inducing no change in spherical equivalent when 2 incisions are made due to coupling effect. However, this method also suffers from limitations such as requiring pachymetry and use of a diamond knife, in addition to controversies regarding application of the nomogram.[4,12] Implantation of toric IOLs is another option, however these lenses are expensive and their implantation requires additional skills; moreover, postoperative rotation remains a major drawback.[6,13] Excimer laser ablation may also be used to correct residual or induced astigmatism after cataract surgery. Major concerns include the cost of the procedure, limited number of centers equipped with excimer machines, adverse effects specific to excimer laser surgery such as loss of BCVA, flap related complications, night vision disturbances and regression.[8,14]

Lever and Dahan[5] reported that 3.5 mm opposite clear cornea incisions straddling the steep axis decreased pre-existing astigmatism by a mean value of 2 D. Corresponding figures using this method have been reported to be 0.5 D by Tadros[15] and 1.5 D by Khokhar.[16] The results obtained in the current study are within the lower range previously reported. In contrast to the previously mentioned methods, paired OCCI on the steep axis is technically easy without need for additional equipment. The same 3.2 mm knife used by most surgeons for routine phacoemulsification cataract surgery is used for making both incisions and therefore no additional cost is entailed. This method is effective for correction of mild to moderate corneal astigmatism, but in eyes with higher degrees of astigmatism it is recommended to use an alternative method or a combination of two or more methods.[17] Some authors recommend a larger clear cornea incision on the steep axis to increase the effect of the procedure while temporary sutures are placed for closing the wound. Disadvantages of this method include the increased risk of endophthalmitis due to the penetrating nature of the incisions as compared to non-penetrating methods. For control of leakage in this method one can use nylon sutures for wound closure.[5]

In conclusion, paired opposite clear corneal incisions on the steep axis are useful for correcting mild to moderate pre-existing astigmatism during cataract surgery. Employing this technique during routine phacoemulsification using a 3.2 mm incision does not require additional instruments and therefore can be performed without altering the surgical setting.

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