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ORIGINAL ARTICLE

Effect of Single and Paired Clear Corneal Incisions on Corneal Astigmatism in Phacoemulsification Surgery

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Abstract

Background: **Astigmatism is a common visual disorder caused by an irregular curvature of the cornea. This can change the way light passes to the retina, causing blurry distorted vision. Unsatisfactory visual acuity following otherwise successful cataract surgery is commonly attributable to the development of postoperative astigmatism.**

Aim and objectives: **To determine the effect of single and paired on-axis clear corneal incisions on preexisting corneal astigmatism during phacoemulsification.**

Patients and methods: **This was a descriptive interventional study conducted in Al-Hussien University Hospital and Cairo Fatemic Hospital (Cairo, Egypt) on 40 eyes with senile cataract, which were divided into two groups: group 1: 20 eyes with corneal astigmatism of 1−2 diopters received single three-step self-sealing corneal incision 1 mm anterior to the limbus using a 2.8 mm keratome on the steep meridian. Group 2: 20 eyes with corneal astigmatism 2 diopters or more received paired opposite three-step self-sealing corneal incision 1 mm anterior to the limbus.**

Result: **The current study found that preoperative visual acuity varied from 0.05 to 0.50 in group A and from 0.05 to 0.50 in group B, whereas postoperative visual acuity varied among 0.6 and 1.0 in group A and from 0.6 to 0.9 in group B. The current study showed that steepest meridian K readings (preoperative) ranged from 41 to 48, in group A and ranged from 44 to 48, in group B, while postoperatively it ranged from 40 to 47.5 in group A and ranged from 41.8 to 46.4in group B. Astigmatism correction was statistically significantly higher in group B than group A.**

Conclusion: **Phacoemulsification, when correcting mild to moderate preexisting regular astigmatism during phacoemulsification, a pair of opposite CCIs on the steep axis is more efficient than a single CCI on the steep axis.**

Keywords: Corneal astigmatism, Corneal incisions, Phacoemulsification surgery

1. Introduction

The main aim of modern cataract surgery is to restore the ability to see without corrective lenses. Visual impairment after cataract surgery is often brought on by uncorrected postoperative astigmatism.[1]

An essential source of corneal astigmatism after surgery is surgically induced astigmatism (SIA), in addition to preexisting corneal astigmatism. It is possible to achieve adequate visual acuity after corneal surgery if preexisting astigmatism can be reduced with SIA. There are a number of methods for correcting vision after cataract surgery, including on-axis opposite clear corneal incisions (OCCIs) or a single OCCI, limbal relaxing incisions (LRIs), femtosecond laser-assisted arcuate keratotomy (FS-AK), implantation of toric intraocular lenses (IOLs), and refractive surgery. For corneal astigmatism of between 1.00 and 3.00 D, on-axis incisions are a simple and effective treatment option.[2]

The goal of this research is to compare the results of phacoemulsification procedures using single and paired on-axis clear corneal incisions for individuals with preexisting corneal astigmatism.

2. Patients and methods

This was a descriptive interventional study conducted in Al-Hussien University hospital (Cairo,

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Egypt) and Cairo Fatemic Hospital (Cairo, Egypt) on 40 eyes with senile cataract which were separated into two groups:

Group 1: 20 eyes with corneal astigmatism of 1–2 diopters received single three-step self-sealing corneal incision 1 mm anterior to the limbus using a 2.8-mm keratome on the steep meridian.

Group 2: 20 eyes with corneal astigmatism 2 diopters or more received paired opposite three-step self-sealing corneal incision 1 mm anterior to the limbus using a 2.8-mm keratome on the steep meridian.

2.1. Inclusion criteria

Age 50 years and older, corneal astigmatism greater than 1 diopter (D), patients with significant senile cataract and uncomplicated phacoemulsification cataract extraction with foldable IOL implantation.

2.2. Exclusion criteria

Patients with a history of uncontrolled systemic (e.g diabetes mellitus) or ocular diseases (e.g., glaucoma) and patients with previous ophthalmic surgery or trauma and patients with intraoperative complications.

2.3. Preoperative assessment

History taking regarding: demography (age and sex) and ocular and systemic diseases.

2.4. Intraoperative

The participant was asked to sit up straight so that the oblique muscles would not twist the cornea when they traced the steep corneal axis on the conjunctiva. Strict sterile procedure was followed during the operation, including the use of povidone iodine 5 % to disinfect the eyelids. Local anesthetic was used for every single procedure.

2.5. Postoperative assessment

At 1 and 3 months from the operation, the following procedures were repeated: Refraction and keratometry by autokeratometer, BCVA using Landolt's chart, anterior segment examination using slit lamp, fundus biomicroscopic examination, and corneal topography using Pentacam.

2.6. Statistical analysis of data

Microsoft Excel was used to code, record, and analyze data from the individual's medical history, physical examination, laboratory tests, and outcome measures. The collected data was tabulated and investigated using SPSS (Statistical Package for the Social Sciences) version 25 (Armonk, NY: IBM Corp) on an IBM-compatible computer.

The data's normality was examined using Kolmogorov–Smirnov and Shapiro–Wilk tests.

Our study was accepted by the ethics committee in Al-Azhar University.

3. Results

There was no significance between the studied groups regarding age and sex, P value greater than 0.05 as shown in Table 1.

There was no significance between the studied groups regarding cisual acuity (preoperative) and (postoperative), P value greater than 0.05 as shown in Table 2.

There was no significance between the studied groups regarding steepest meridian K readings (preoperative) (postoperative), P value greater than 0.05 as shown in Table 3, Fig. 1.

There was high significance between the studied groups regarding astigmatism preoperatively and postoperatively ($P < 0.001$) as shown in Table 4.

There was high significance between the studied groups regarding astigmatism correction preoperatively) and postoperatively, $P < 0.001$ as shown in Table 5.

4. Discussion

Clear corneal cataract incisions that do not require sutures have been gaining popularity across the world ever since they were first introduced as an alternative to the more commonplace scleral tunnel and limbal incision techniques. These include quicker visual recovery, less time spent in the hospital, less pain and bleeding, and no astigmatism caused by sutures.[3]

Table 1. Demographic data distribution of the cases investigated.

Demographic data	Group A ($n = 20$) No. (%)	Group B ($n = 20$) No. (%)	*P*. value
Sex			
Male	4 (20.0 %)	4 (20.0 %)	1.0
Female	16 (80.0 %)	16 (80.0 %)	
Age (y)			
(Min–max)	53–70	51–68	0.120
Mean ± SD	62.50 ± 5.59	60.30 ± 5.39	

Table 2. Preoperative and postoperative visual acuity in groups A and B.

Visual acuity	Group A ($n = 20$)	Group B ($n = 20$)	*P* value
Preoperative			
(Min– max)	0.05–0.50	0.05–0.50	
Mean ± SD	0.27 ± 0.14	0.23 ± 0.14	0.3719
Postoperative			
(Min– max)	0.6–1.0	0.6–0.9	0.7672
Mean ± SD	0.75 ± 0.12	0.74 ± 0.09	

SD, standard deviation.

Table 3. Preoperative and postoperative steepest meridian K readings in groups A and B.

Steepest Meridian K Readings	Group A ($n = 20$)	Group B ($n = 20$)	*P* value
Preoperative			
(Min–max)	41.00–48.60	44.00–48.00	
Mean ± SD	45.42 ± 2.06	46.21 ± 1.23	0.1491
Postoperative			
(Min–max)	40.00–47.50	41.80–46.40	
Mean ± SD	44.40 ± 2.14	44.44 ± 1.52	0.9460

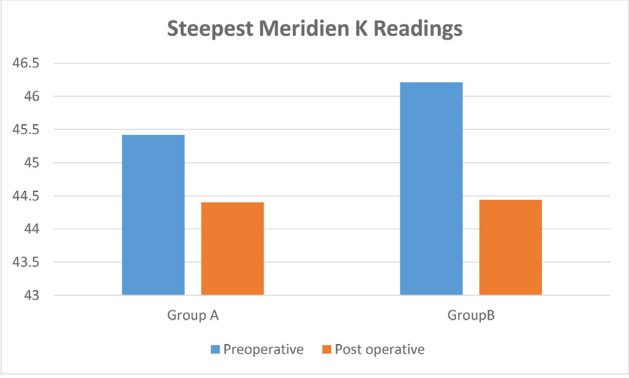

Fig. 1. Steepest meridian K readings.

Table 4. Preoperative and postoperative astigmatism in groups A and group B.

Astigmatism	Group A ($n = 20$)	Group B ($n = 20$)	*P* value
Preoperative			
(Min–max)	1.00–2.00	2.25–4.50	<0.0001*
Mean ± SD	1.65 ± 0.36	3.33 ± 0.74	
Postoperative			
(Min–max)	0.25–1.75	1.00–3.00	<0.0001*
Mean ± SD	0.87 ± 0.43	1.90 ± 0.54	

Table 5. Comparison between astigmatic correction in groups A and B.

Astigmatic correction	Group A ($n = 20$)	Group B ($n = 20$)	t	*P*-value
(Min–max)	0.25–1.25	0.50–2.25	−4.731	<0.001**
Mean ± SD	0.78 ± 0.29	1.43 ± 0.54		

t: Paired samples Student's *t*-test,**: *P*-value less than 0.001, statistically significant.

Preexisting regular corneal astigmatism among people receiving phacoemulsification for cataracts and compared the results obtained with a single CCI on the steep axis to those obtained with OCCIs. Each OCCI in the present research was constructed as a one-step CCI with a 2.6 mm disposable keratome, resulting in an incision length of around 2 mm.[4]

Our results showed that the gender distribution of Group A included 4 men (20 %) and 16 girls (80 %). The ages in Group A varied from 53 to 70, with a mean SD of 62.50 ± 5.59 years, whereas in Group B it varied between 51 and 68 years, with a mean ± SD of 60.30 ± 5.39 years. There was no significance between the studied groups regarding age and sex, *P* value greater than 0.05.

Our results supported those of Liu and colleagues, who reported that there was no significance regarding sex and age.[5]

We found that there was no significance between the studied groups regarding visual acuity preoperatively and postoperatively, *P* value greater than 0.05.

Our results were similar to Liu and colleagues, who demonstrated that there was no significance between the studied groups postoperatively regarding visual acuity.[5]

Also, Mendicute and colleagues conducted a randomized, prospective clinical investigation contrasting the efficacy of toric IOL implantation with that of paired OCCIs for astigmatism correction in cases undergoing cataract surgery. The averages of the preoperative and postoperative Uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA) in both groups are shown in our research. In the OCCI group, 80 % of eyes had a UCVA of 20/40 or greater, and 50 % had a UCVA of 20/25 or better. This group's eyes all had best corrected visual acuity of 20/25 or greater.[6]

Our findings showed that there was no significance between the studied groups regarding Steepest meridian K readings preoperatively postoperatively, *P* value greater than 0.05.

Similar to our results, Rafaat and Hatem (2021) demonstrated that in the OCCI group of the aforementioned study, there was highly significant variance among the preoperative mean K1 (43.35 ± 1.59) compared with the postoperative (43.24 ± 1.65). Similarly, there was highly significant difference between the preoperative mean K2 (45.36 ± 2.00) compared with postoperative (44.52 ± 1.93), while in the single incision group, there was non-significant difference between the preoperative mean K1 (42.16 ± 1.14) compared with postoperative (42.20 ± 1.18). However, a statistically significant distinction existed among the preoperative mean K2

(44.13 ± 1.26) compared with the postoperative (43.71 ± 1.20).[7]

There was a high significance between the studied groups regarding astigmatism preoperatively and postoperatively, ($P < 0.001$).

Rafaat and Hatem. (2021) reported that there was a high significance between the studied groups regarding preoperative and postoperative astigmatism.[7]

Topographic corneal astigmatism before and after surgery was 1.95 D±0.83 (SD) and 1.93 D±0.51 (SD) and 1.53 D±0.62 (SD) in Group A (paired OCCIs) and Group B (single CCIs), respectively. The postoperative mean astigmatism values of the two groups were significantly different. Using a vector-corrected technique, the average surgically induced astigmatism in Group A was 1.2 ± 80.11 D, while in Group B it was 1.09 ± 0.13 D ($P = 0.00$).[8]

Also, Khokhar and colleagues demonstrated that there was a high significance between the studied groups regarding astigmatism preoperatively and (postoperatively ($P = 0.00$).[9]

Our current study showed that there was a high significance between the studied groups regarding astigmatism correction ($P < 0.001$).

Similarity, in the Lever and Dahan study 33 eyes with astigmatism larger than 2.00 D before cataract surgery were treated with paired OCCIs measuring 2.8–3.5 mm. Astigmatism mean correction was 2.06 D with this technique.[10]

In a study by Mendicute and colleagues, the preoperative corneal astigmatism score of a single individual increased, and axis displacement was also recorded. The inability of the cornea to recover properly with age was blamed for the over flattening. Individuals before surgery topography was indicative of irregular astigmatism, according to a review of his medical records.[6]

Also, Chiam (2015) carried out a retrospective assessment to evaluate the refractive effects of paired OCCIs on with-the-rule (WTR) and against-the-rule (ATR) astigmatism at 1 and 6 months postoperatively. A coupled OCCI has a significantly greater refractive effect on WTR than ATR astigmatism correction. At 6 months, the SIA decreases significantly more for ATR astigmatism correction than for WTR astigmatism correction.[11]

Also, Qammar and Mullaney (2005) demonstrated that there was a significance between preoperative and postoperative astigmatism correction.[12]

4.1. Conclusion

For preexisting regular astigmatism of mild to moderate severity, paired opposing CCIs on the steep axis are more successful than a single CCI after phacoemulsification. This method may be used during standard phacoemulsification through a 2.8 mm incision without requiring any supplementary tools or adjustments to the existing surgical protocol.

4.2. Limitation

This study had some limitations. This was a retrospective study. Moreover, the follow-up time was relatively short; therefore, research into long-term outcomes is necessary. Furthermore, the limited number of patients enrolled reduced the statistical power of the analysis.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

Conflicts of interest

The authors declared that there were no conflicts of interest.

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