Original Article

Effect of biaxial versus coaxial microincision cataract surgery on optical quality of the cornea

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Context: Visual function is determined by a combination of the cornea, which has a larger effect and internal aberrations generated by the intraocular lens and those induced by the surgery. These corneal refractive changes are related to the location and size of the corneal incision. The smaller the incision, the lower the aberrations and the better the optical quality. **Aims:** To compare the effect of uneventful coaxial versus biaxial microincision cataract surgery (MICS) on the corneal aberrations. **Settings and Design:** Retrospective interventional nonrandomized comparative case study comprised 40 eyes of 36 patients with primary senile cataract. **Subjects and Methods:** They were divided into two groups: Group I (20 eyes) had operated by biaxial MICS and Group II (20 eyes) had operated by coaxial MICS. Each group were assessed by corneal topography and wavefront analysis over 6 mm pupil size preoperatively and 1-month postoperatively. **Statistical Analysis Used:** Statistical analysis was performed using SPSS for Windows (version 17.0.1, SPSS, Inc.). The paired *t*-test was used to compare the mean values of corneal aberrations preoperatively and 1-month postoperatively in each group. **Results:** There was a significant increase in trefoil and quatrefoil in biaxial MICS ($P = 0.063$, 0.032 respectively) while other aberrations insignificantly changed. The coaxial MICS showed a significant increase in root mean square (RMS) of total high order aberrations (HOAs) ($P = 0.02$) and coma (0.028), but not the others. In comparison to each other, there was the insignificant difference as regards astigmatism, RMS of individual and total HOAs. **Conclusions:** Coaxial and biaxial MICS are neutral on corneal astigmatism and aberrations.

Key words: Cataract surgery, corneal aberrations, corneal astigmatism, high order aberrations, microincision cataract surgery

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Today with the era of the premium intraocular lens (IOLs) including aspherical monofocal and multifocal IOLs, which aim to reduce the positive spherical aberrations of the cornea to improve the retinal image.[1] This necessitates an insignificant change in the optics of the cornea as the quantity (astigmatism) and quality (high order aberration [HOA]).[2] However, several studies reported that cataract surgery degrades the optical quality and quantity of the cornea, which is related to corneal incision size.[3-5]

The aim of this study was to determine whether microincision cataract surgery (MICS) effectively decreases corneal HOAs during cataract surgery.

Subjects and Methods

Retrospective cumulative interventional nonrandomized comparative case study comprised 40 eyes of 36 patients with visual significant primary senile cataract (graded according to Lens Opacities Classification System III for grading cataract as regards to nuclear color, nuclear opalescence, cortical, and posterior subcapsular cataract).

Inclusion criteria included age between 48 years and 81 years, clear cornea, no history of previous ocular surgery, or glaucoma, central corneal thickness (CCT) <600 μm and pupil sized >5 mm. Diseases known to decrease contrast sensitivity function (e.g., macular disorders or ocular surface disease) as well as diseases that affect IOL centration (e.g., sublaxated lens or pseudoexfoliation) were excluded from this study.

The routine complete ophthalmic examination was performed for every case preoperatively and 1-month postoperatively. The corneal astigmatism, corneal topography and wave front analysis were measured (Optikon corneal topographer) for a 6.0 mm aperture diameter pre- and post-operatively at 1-month interval for total HOA, coma Z (3, +1), spherical Z (4, +0) (reported with its sign), trefoil, quatrefoil, and secondary astigmatism.

All patients gave adequate informed consent.

Peribulbar anesthesia (lidocaine 2% + bubicain + hyalaze of 15 IU/ml) associated with mild sedation with midazolam was used in all cases.

The same surgeon (I.H.) did biaxial MICS for 20 cases. Two clear corneal incisions (of 1.4 mm) were made superiorly by Alcon 19G MVR with 90º apart. He did also coaxial MICS for

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20 cases. A 2.2 mm clear corneal microincision was placed superiorly using 2.2 mm keratome. A 1.0 mm paracentesis was made 90º apart with 20G MVR (Alcon Laboratories). An Infiniti phacoemulsification platform (Alcon Laboratories) was used with a 30º, 0.9 mm caliber phacoemulsification tip (micro tip) with vertical chopping technique.

AcrySof SN60WF was loaded in the cartridge D (Alcon Laboratory) and then inserted in a Royal injector. The tip of the cartridge was introduced partially into the external part of the incision, after which the IOL was injected into the capsular bag. After that, the ophthalmic visco-surgical device was removed; the incisions were hydrated in both groups using a 30G cannula (Alcon). No sutures were used in any cases.

Postoperative topical therapy included a combination of topical antibiotics moxifloxacin 0.3% (Vigamox) and nonsteroidal anti-inflammatory drugs keratolac (0.4%) (Acular) for 6 times daily for a week then reduce it gradually over 1-month.

Sample size calculation

The required sample size was calculated using the G*Power software version 3.1.7 (Universität Düsseldorf, Germany).

The primary outcome measures were the differences between preoperative and postoperative total root mean square (RMS), spherical aberration, and coma.

Since there was no adequate information regarding the expected outcome measures associated with the biaxial technique, sample size calculation for the current study was based on targeting an effect size that would be clinically relevant.

Consequently, it was estimated that a sample size of 20 patients in either study group would achieve a power of 80% to detect a statistically significant difference between the two groups as regards the outcome measures for a large effect size (Cohen's d) of 0.9 using a two-sided independent-samples *t*-test with a confidence level of 95% (type I error, 0.05).

This sample size of 20 patients per group was estimated to have a power of 80% to detect statistical significance for an effect size (dz) of 0.66 as regards the within-group change in total RMS, spherical aberration, and coma using a two-sided paired *t*-test with the same confidence level of 95%.

These effect sizes were chosen as they were considered to be clinically relevant differences to seek in this exploratory study.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS©) version 17.0.1 (SPSS©, Inc., Chicago, IL, USA).

Numerical variables were presented as mean ± standard deviation (SD) and intergroup differences were compared using the independent-samples *t*-test. Within-group comparison of numerical variables was done using the paired-samples *t*-test.

Categorical variables were presented as number (%) and between-group differences were compared using the Pearson Chi-squared test.

All statistical tests were two-sided and significance was targeted at the 95% confidence level, that is, a $P < 0.05$ was considered statistically significant.

Results

Forty eyes of 36 patients were enrolled in this study. The mean age of the patients was 58.73 years (range 48–81 years). The biaxial group comprised 20 eyes of 17 patients and the coaxial MICS group, 20 eyes of 19 patients. Table 1 shows the patients' characteristics.

There is no statistically difference between 2 groups as regards preoperative corneal power, astigmatism, RMS of total and individual HOA. In biaxial MICs group, the mean corneal power was 43.13D ± 2.39 (SD) preoperatively and 43.03D ± 2.17 (SD) 1-month postoperatively, there was no statistically significant difference in corneal power ($P = 0.16$). While in coaxial MICS group, the mean corneal power was 43.09D ± 1.14 (SD) preoperatively and changed statistically insignificantly ($P = 0.58$) to 43.09D ± 0.96 (SD) 1-month postoperatively. The mean corneal astigmatism did not show statistically significant changes in both groups (biaxial MICS increased from 0.55D ± 0.25 preoperatively to 0.68D ± 0.28 at 1-month postoperatively, while coaxial MICS astigmatism changed from 1.1D ± 1.0 preoperatively to 1.1D ± 0.049 1 m postoperatively).

The RMS value of the total corneal aberrations increased insignificantly and slightly after biaxial MICS (0.5 μm ± 0.09 preoperatively to 0.57 μm ± 0.23 postoperatively) ($P = 0.49$), but coaxial MICS show significant increase of total RMS from 0.49 ± 0.21 μm –0.67 ± 0.31 μm preoperatively and postoperatively respectively ($P = 0.02$).

Analysis of individual Zernike terms showed mean astigmatism and spherical aberration did not change significantly in both groups. On the other hand, trefoil and quatrefoil increased significantly in biaxial ($P = 0.036$, 0.032 respectively) and not in coaxial MICS ($P = 0.21$, 0.16 respectively), while coma increased significantly in coaxial MICS ($P = 0.028$) but not in biaxial MICS ($P = 0.78$) as shown in Table 2. Figs. 1 and 2 show pre- and post-operative wave front analysis of a case in each group as an example.

Table 3 and Fig. 3 show the insignificant difference in corneal astigmatism and aberrations between 2 groups. The RMS values for corneal astigmatism and most of HOA were slightly better, but not significant in coaxial MICS group than in the biaxial MICS group except coma and total HOA which were increasing more in coaxial.

Discussion

Recently, the cataract surgery is considered as refractive procedure aiming high patient satisfaction with better

Table 1: Patient demographics

	Biaxial group	Coaxial group
Patients	17	19
Age (mean±SD)	58.32±6.9	59.76±7.1
Sex (%)		
Male	8 (47)	9 (47.3)
Female	9 (53)	10 (52.7)
Eye (%)	20	20
Right	11 (55)	8 (40)
Left	9 (45)	12 (60)

SD: Standard deviation

Table 2: The mean preoperative and 1 m postoperative corneal astigmatism and aberrations

	Biaxial group			Coaxial group		
	Preoperative (mean±SD)	Postoperative (mean±SD)	*P*	Preoperative (mean±SD)	Postoperative (mean±SD)	*P*
Corneal power	43.13±2.39	43.03±2.17	0.16	43.09±1.14	43.09±0.96	0.58
Astigmatism	0.36±0.21	0.55±0.31	0.21	0.99±0.97	1.05±0.5	0.4
Spherical	0.28±0.09	0.26±0.11	0.89	0.2±0.09	0.23±0.07	0.48
Coma	0.21±0.17	0.24±0.13	0.78	0.2±0.17	0.32±0.22	0.028
Trefoil	0.19±0.13	0.41±0.24	0.036	0.26±0.22	0.39±0.26	0.21
Quatrefoil	0.06±0.06	0.19±0.14	0.032	0.14±0.14	0.2±0.13	0.16
Secondary astigmatism	0.1±0.1	0.2±0.21	0.16	0.09±0.05	0.06±0.03	0.33
Total RMS	0.5±0.09	0.57±0.23	0.49	0.49±0.21	0.67±0.31	0.02

SD: Standard deviation, RMS: Root mean square

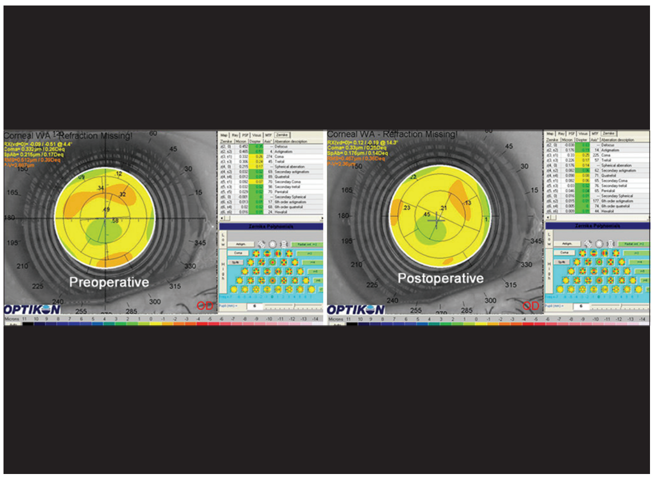

Figure 1: Insignificant change seen in corneal aberrations for patient undergone biaxial microincision cataract surgery

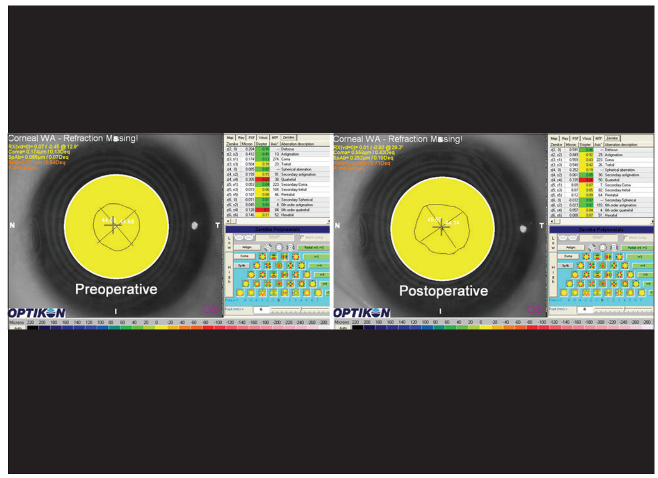

Figure 2: Insignificant change seen in corneal aberrations for patient undergone coaxial microincision cataract surgery

functional vision. This functional vision (contrast sensitivity) depends on interaction between corneal aberrations and internal aberrations especially with IOL.[2]

It has been documented that cataract surgery with standard IOL implantation induces and increases HOAs that are not effectively corrected with spectacles and limiting the performance of the eye. This increase of HOA is directly related to the size of cataract surgery.[6,7]

With the era of premium aspheric IOLs which reduce SA of the cornea to achieve perfect retinal image, they necessitate relative unchanged or stable corneal aberration.[5,8] We believe that minimizing the effect of corneal incisions on induced aberrations could be achieved by decreasing size of corneal incisions of cataract surgery. New techniques and advances in cataract surgery have succeeded in reducing the surgery to be done through 2 mm incision safely which is called MICS. MICS is including biaxial MICS (through 1.4 mm incision) and Coaxial MICs (through 2.2 mm incision).[9,10]

The main advantages of MICs are decreasing surgically induced astigmatism, corneal aberrations and postoperative inflammation. But which of them (biaxial versus coaxial) is more neutral on astigmatism and optical quality of the cornea?

In our study, corneal power and astigmatism slightly, but not significantly, reduced in coaxial than biaxial MICS. Thus in agreement with Alio's study,[11] When the aberrations were evaluated by Zernike analysis in this study, we found the biaxial MICs significantly changed the trefoil and quatrefoil ($P = 0.036$ and 0.032 respectively), which is most probably related to corneal incisions. While other aberration changed insignificantly. This agrees with results of Elkady *et al*.[12] Coaxial MICs significantly increased the coma and RMS of total HOA ($P = 0.028$ and 0.02, respectively). This finding is in agreement with other studies as regards coma but not total HOA.[3,12-14]

In comparison the both groups, the individual corneal aberrations except coma and RMS of total aberration was slightly, but not significantly, changed in the coaxial MICs than biaxial MICs. This agrees with other studies.[11,12]

Conclusion

Microincision cataract surgery (either biaxial [1.4 mm] or coaxial [2.2 mm]) was able to provide an astigmatically neutral incision. It was effective in maintaining normal corneal asphericity with respect of corneal prolateness in addition to other aberrations. These findings confirm that using the

Table 3: The mean change in different corneal aberration and total RMS in both groups

Mean change	Biaxial group (mean±SD)	Coaxial group (mean±SD)	*P*
Corneal power	−0.094±0.64	−0.004±0.34	0.73
Astigmatism	0.17±0.38	0.05±0.54	0.56
Spherical	−0.017±0.09	0.02±0.07	0.41
Coma	0.03±0.15	0.12±0.13	0.17
Trefoil	0.22±0.26	0.13±0.23	0.53
Quatrefoil	0.12±0.11	0.053±0.109	0.41
Secondary astigmatism	0.09±0.18	−0.03±0.06	0.17
Total RMS	0.07±0.18	0.18±0.17	0.35

SD: Standard deviation, RMS: Root mean square

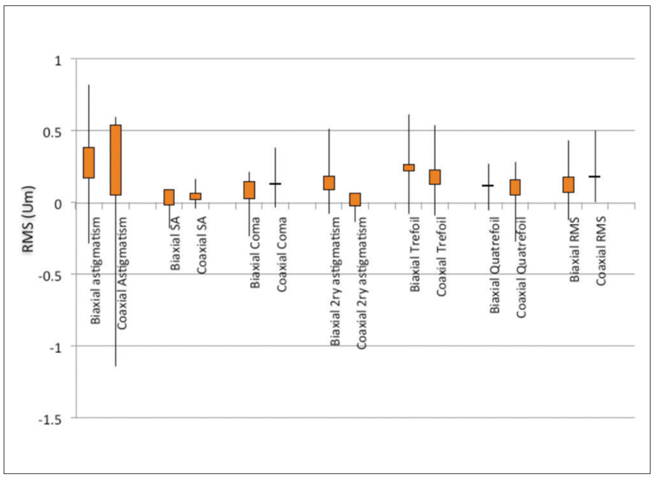

Figure 3: Insignificant change seen in corneal astigmatism and aberrations between 2 groups

smallest incision in sub-2.0 mm surgery improves control of the optical performance of the human eye.

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Conflicts of interest

There are no conflicts of interest.

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