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Multifocal intraocular lens implantation after previous hyperopic corneal refractive laser surgery

Violette Vrijman, MD, Jan Willem van der Linden, BOpt, PhD, Ivanka J.E. van der Meulen, MD, PhD, Maarten P. Mourits, MD, PhD, Ruth Lapid-Gortzak, MD, PhD

Purpose: To describe the outcomes in terms of the refraction and visual acuity of multifocal intraocular lens (IOL) implantation in patients with previous hyperopic corneal refractive laser surgery.

Setting: Academic Medical Center, University of Amsterdam, Amsterdam, and Retina Total Eye Care, Driebergen, the Netherlands.

Design: Retrospective case series.

Methods: Results were analyzed 3 months after implantation of a multifocal IOL (Acrysof Restor SN6AD1) in patients after previous corneal refractive laser surgery for hyperopia. The primary outcome measures were uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), and refraction. The secondary outcome measures were the number of laser enhancements and posterior capsule opacification (PCO) rates.

Results: Forty eyes of 40 patients were included. Sixteen eyes (40.0%) had lens extraction because of cataract, and 24 eyes (60.0%) had refractive lens exchange. The mean postoperative UDVA was 0.16 logarithm of the minimum angle of resolution (logMAR) ± 0.18 (SD), and the mean postoperative CDVA was 0.01 ± 0.08 logMAR. The mean postoperative spherical equivalent was 0.04 ± 0.92 diopter (D). Twenty-five eyes (62.5%) were within ±0.50 D of emmetropia, and 35 eyes (87.5%) were within ±1.0 D of emmetropia. Nine eyes (22.5%) had a laser enhancement because of a residual refraction error. Eleven eyes (27.5%) had a neodymium:YAG laser capsulotomy because of PCO.

Conclusions: In general, multifocal IOL implantation after corneal refractive laser surgery for hyperopia resulted in good visual acuity and refraction. The magnitude of previous hyperopia did not influence the refractive predictability.

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Today, corneal refractive laser surgery is in widespread use. Previous studies[1,2] have shown good results for myopia and low to moderate hyperopia. Most patients who have had refractive laser surgery have a strong desire for independence from spectacles. When they develop presbyopia or cataract, they might seek other options to recover spectacle independence.

Multifocal intraocular lenses (IOL) have been shown to provide good visual quality for distance and near, with a high rate of spectacle independence.[3–5] Halos and decreased contrast sensitivity are the most common side effects, but they are usually well tolerated by patients.[3,6] Patients who have had previous refractive laser surgery and a cataract or presbyopia who wish for spectacle independence could be offered multifocal IOL implantation. Surgeons might be reluctant to do this because of the assumption that after refractive laser surgery the cornea will have become "multifocal" and that implantation of a multifocal IOL could deteriorate visual acuity and visual quality. However, some previous studies[7–11] found good results for multifocal IOL implantation after previous corneal refractive laser surgery for myopia and hyperopia.

Intraocular lens calculation is less accurate after corneal laser surgery. There are 3 main reasons for this inaccuracy. The first is instrument error; because of incorrect measurements of the anterior corneal curvature, the determination of the true total corneal power is an inaccurate. Second is the index of refraction error; the index of refraction is based on the relationship between the anterior and posterior corneal curvatures, and this relationship is altered by the

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From the Department of Ophthalmology (Vrijman, van der Meulen, Mourits, Lapid-Gortzak), Academic Medical Center, University of Amsterdam, Amsterdam, and Retina Total Eye Care (van der Meulen, van der Linden, Lapid-Gortzak), Driebergen, the Netherlands.

Jan Willem de Koning participated and assisted the authors in the intraocular lens calculations.

Corresponding author: Ruth Lapid-Gortzak, MD, PhD, Department of Ophthalmology, Academic Medical Center, Meibergdreef 9, 1100 AZ Amsterdam, the Netherlands. E-mail: r.lapid@amc.nl.

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laser. The third reason is formula error; most modern IOL calculation formulas use the keratometry and axial length values for the estimated lens position. The changed corneal curvature causes an error in this prediction because the anterior chamber dimensions are not really changed.[12] This inaccuracy in IOL calculation makes the results less predictable than they are in virgin eyes, causing an overestimation of IOL power in the case of a hyperopic laser. However, new IOL calculation formulas that increase the accuracy in eyes with previous refractive laser surgery have been developed.[13–15]

For the above-mentioned reasons, reports of multifocal IOL implantation after corneal refractive laser surgery are scarce. In this study, we evaluated the visual and refractive results of multifocal IOL implantation after previous hyperopic laser surgery in a cohort of 40 eyes.

PATIENTS AND METHODS

This single-center retrospective study included eyes of consecutive patients. The study was performed according to the tenets of the Declaration of Helsinki, and the study protocol was reviewed by the Medical Ethics Committee of the Academic Medical Center of Amsterdam. In conformance with the consensus of the Dutch Society of Refractive Surgery,[A] data were collected prospectively.

Inclusion and Exclusion Criteria

Included were eyes that had previous hyperopic corneal refractive laser surgery by laser in situ keratomileusis (LASIK) with cataract or presbyopia and that had phacoemulsification with implantation of an Acrysof Restor SN6AD1 multifocal IOL (Alcon Laboratories, Inc.) between March 2008 and March 2015 at the Retina Total Eye Care Center (Driebergen, the Netherlands). The multifocal IOL has an anterior apodized diffractive aspheric surface with a central diffractive zone and has an addition of +3.0 diopters (D). For statistical reasons, only 1 eye per patient was included by randomization (Research Randomizer 4.0[B])study. Eyes with a target refraction for reading were also included. Although not all these eyes had a hyperopic refraction before the laser treatment, they had a hyperopic laser ablation to attain the myopic target refraction. Exclusion criteria were macular disease, glaucoma, a history of retinal detachment, toric Restor multifocal IOL implantation, amblyopia with a (CDVA) before the initial laser surgery of worse than 0.1 logarithm of the minimum angle of resolution (logMAR), and corneal disease other than refractive surgery with LASIK.

Surgical Technique

Patients who had previous hyperopic laser treatment were treated with a Zyoptix 217 Z100 excimer laser (Bausch & Lomb, Inc.) using the Keracor 3.21 dataware nomogram. Laser enhancements required after phacoemulsification because of residual refractive error were performed using a standard tissue-saving nomogram (Bausch & Lomb, Inc.).

Phacoemulsification was performed using local anesthesia performed by 1 of 2 surgeons (I.J.E.M., R.L.-G.) and the Ozil phaco device (Alcon Laboratories, Inc.). The IOLs were implanted through a 2.2 mm incision with a Monarch D cartridge and Monarch II injector (Alcon Laboratories, Inc.). The phacoemulsification procedure was unchanged during the study period.

Patient Assessment

All patients had a full ophthalmic examination before and after the initial corneal refractive laser treatment and before and after IOL implantation. It included uncorrected distance visual acuity (UDVA) and CDVA, manifest refraction, slitlamp biomicroscopy, Goldmann applanation tonometry, and binocular fundoscopy. Corneal topography imaging (Orbscan, Bausch & Lomb, Inc.), including the corneal irregularity indices at the 3.0 mm and 5.0 mm zones, and biometry using partial coherence interferometry (PCI) (IOLMaster 2 and 5.1, Carl Zeiss Meditec AG) were performed before IOL implantation only.

Intraocular Lens Power Calculation

The IOL calculation was performed using the American Society of Cataract and Refractive Surgery (ASCRS) calculator.[C] The refractive and keratometry data from before and after the corneal laser treatment and the biometric data from the PCI device were imported into the online calculator. The IOL powers of the following formulas were calculated: clinical history, Feiz-Mannis, corneal bypass, Masket, modified Masket, Haigis-L, Shammas (added to calculator during study period), and the average of those formulas, the latter being the preferred formula. The postoperative target was emmetropia. Contact lens overrefraction was used in some cases.

Outcome Measures

The primary outcome measures were UDVA, CDVA, and refraction. The secondary outcome measures were the number of laser enhancements and posterior capsule opacification (PCO) rates. For the visual and refractive outcomes, the 3-month postoperative results were used. The longest available follow-up data were used for the secondary outcomes of PCO rate and number of corneal laser enhancements. Follow-up was at least 1 year.

Statistical Analysis

Data analysis was performed with SPSS for Windows software (version 22.0, IBM Corp.). Normal distribution of data was checked with normal probability plots and the Kolmogorov-Smirnov and Shapiro-Wilk tests. A *t* test or Mann-Whitney *U* test, depending on normality, was used to compare the outcomes between groups. A *P* value less than 0.05 was considered statistically significant.

RESULTS

The study comprised 40 eyes of 40 patients (22 men, 18 women). Sixteen eyes (40.0%) had lens extraction because of cataract, and 24 eyes (60.0%) had refractive lens exchange. Table 1 shows the patients' demographics.

Phacoemulsification with multifocal IOL implantation of was uneventful in all cases. The mean spherical equivalent (SE) after lens extraction and IOL implantation was 0.04 ± 0.92 D. The absolute error of the mean SE was 0.61 ± 0.68 D. The mean postoperative UDVA was 0.16 ± 0.18 logMAR. The mean postoperative CDVA was 0.01 ± 0.08 logMAR. The mean postoperative uncorrected near visual acuity was 0.16 ± 0.24 logMAR. Figure 1

Table 1. Patient demographics.

Demographic	Mean ± SD	Range
Age at lens extraction (y)	62.9 ± 6.9	41, 76
Pre-laser SE (D)	1.53 ± 1.23	−1.50, 4.25
Post-laser SE (D)	−0.57 ± 0.92	−2.25, 0.50
Pre-IOL SE (D)	0.66 ± 1.13	−2.38, 2.75
Pre-IOL mean K value (D)	44.76 ± 1.59	41.88, 47.96
Axial length (mm)	23.06 ± 0.98	21.37, 25.69
Implanted IOL power (D)	21.11 ± 2.91	14.50, 26.50

IOL = intraocular lens; K = keratometry; SE = spherical equivalent