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Multifocal intraocular lens implantation after previous corneal refractive laser surgery for myopia

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

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

Design: Retrospective cohort study.

Methods: The 3-month results after implantation of a multifocal IOL (Acrysof Restor) in patients who had corneal refractive laser surgery for myopia were analyzed. The primary outcome measures were corrected distance visual acuity, uncorrected distance visual acuity (UDVA), and refraction. The secondary outcome measures were number of laser enhancements, corneal irregularity, pre-laser magnitude of myopia, and posterior capsule opacification (PCO) rate.

Results: Seventy-seven eyes of 43 patients were included. Twenty-nine eyes had lens extraction because of cataract, and 48 eyes had a refractive lens exchange. The mean postoperative UDVA was 0.14 logarithm of minimum angle of resolution ± 0.22 (SD). The mean postoperative spherical equivalent was −0.38 ± 0.78 diopter (D). Fifty-seven percent of eyes were within ±0.50 D of emmetropia, and 86% were within ±1.0 D. Sixteen eyes (20.8%) had laser enhancement because of residual refraction. Fourteen eyes (18.2%) had a neodymium:YAG laser capsulotomy because of PCO. Eyes with pre-laser myopia greater than 6.0 D had a less predictable outcome than eyes with pre-laser myopia less than 6.0 D ($P = .026$).

Conclusions: Multifocal IOL implantation after corneal refractive laser surgery for myopia resulted in good visual acuity and refraction. Results were less predictable with myopia greater than 6.0 D.

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Corneal refractive laser surgery is considered a safe procedure with good refractive outcomes.[1] Millions of patients have had refractive corneal laser surgery; as they age, these patients will develop presbyopia or cataract. Because they have had refractive surgery, they are likely to see themselves as candidates for another refractive procedure such as multifocal intraocular lens (IOL) implantation.

Multifocal IOLs have been successfully implemented in clinical practice and have good effectivity for distance and near visual acuity; the reported visual side effects include decreased contrast sensitivity and halos.[2–5] Contraindications for multifocal IOL implantation include glaucoma, retinal pathology, and previous corneal surgery.[6] One reason for excluding eyes that have had corneal laser surgery is the assumption that these corneas have been rendered multifocal by the corneal laser procedure and that a multifocal IOL will cause further deterioration of visual function. Another reason is that the postoperative refractive accuracy is undermined by the difficulty of IOL power calculation in eyes that have had corneal laser surgery. This difficulty is caused by 2 factors: (1) inaccurate determination of the total corneal refractive power[7] because the ratio between the anterior and posterior curvatures of the cornea is changed by the myopic laser treatment and, possibly, because of a forward shift of the posterior corneal surface[8]; (2) incorrect estimation of the effective lens position by many IOL calculation formulas when post-laser corneal powers are used.[9]

In this study, we present the results of multifocal IOL implantation for refractive lens exchange or cataract in a cohort of patients who had corneal refractive laser surgery

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for myopia. The patients desired spectacle independence, including freedom from presbyopia correction. The visual and refractive results were analyzed, including the number of laser enhancements. Reports of this kind are scarce[10–12] due to the controversial indication, the difficulty in IOL power calculation, and possibly because most ophthalmologists have not embraced the use of multifocal IOLs in their practices.

PATIENTS AND METHODS

This single-center retrospective study evaluated consecutive eyes with a history of previous corneal refractive laser surgery for myopia that had multifocal IOL implantation for cataract or presbyopia between March 2008 and March 2015 at the Retina Total Eye Care Center (Driebergen, the Netherlands). The study adhered to the tenets of the Declaration of Helsinki and was reviewed by the Medical Ethics Committee of the Academic Medical Center of Amsterdam. Data were gathered prospectively to conform to the consensus of the Dutch Society of Refractive Surgery.[A] All patients gave signed informed consent preoperatively to use the anonymized data for analysis and scientific publication.

Inclusion criteria were patients with cataract or presbyopia who had laser refractive surgery for myopia (laser in situ keratomileusis [LASIK], laser-assisted subepithelial keratectomy [LASEK], or photorefractive keratectomy [PRK]) and received an Acrysof Restor multifocal IOL (Alcon Laboratories, Inc.) to resolve the diminished visual acuity or to correct the presbyopia. Exclusion criteria were amblyopia with an initial corrected distance visual acuity (CDVA) of less than 0.1 logarithm of minimum angle of resolution (logMAR), glaucoma, macular disease, a history of retinal detachment, a toric Restor multifocal IOL, and previous corneal disease other than refractive surgery (LASIK, LASEK, PRK).

Patient Examinations

A full ophthalmic examination was performed before the laser treatment and before and after multifocal IOL implantation. It included uncorrected distance visual acuity (UDVA), CDVA, automated and manifest refraction including spherical equivalent (SE), slitlamp biomicroscopy, tonometry, and dilated indirect fundoscopy. Corneal topography imaging (Orbscan, Bausch & Lomb, Inc.) including the corneal irregularity index and optical biometry (IOLMaster 2 and 5.1, Carl Zeiss Meditec AG) were performed preoperatively. Corneal topography was graded as a prolate or oblate pattern by 2 examiners independently (R.L.-G., V.V.). In most cases, the topography was graded similarly; when it was dissimilar, a definitive grading was made after reexamination of the topography by the 2 examiners together. For IOL calculation, the American Society of Cataract and Refractive Surgery (ASCRS) IOL power calculator[9] was used by entering the refractive and keratometry data from before and after the corneal laser treatment, when available, plus the biometric data of the optical biometer. In some cases, contact lens over-refraction was performed. The approach to IOL calculation was not uniform; it has developed over the past 7 years using post-laser calculations. A multiformula approach was generally used, and the choice of IOL was based on the targeted postoperative emmetropia. The data recorded from the corneal refractive surgery were flap diameter, refraction treated, and target refraction. The effect of the amount of pre-laser myopia on the postoperative refractive result was analyzed to determine whether the magnitude of myopia influenced the outcome.

The follow-up was a minimum of 1 year. For the primary endpoints, visual and refractive outcomes at 3 months were used. For the secondary outcomes of posterior capsule opacification (PCO) rate and number of corneal laser enhancements, the longest available follow-up data were used.

Table 1. Patient demographics.

Demographics	Value
Eyes (n)	77
Number of patients	43
Sex (male/female)	20/23
Previous LASIK, number of eyes (percentage)	59 (76.6)
Previous LASEK, number of eyes (percentage)	6 (7.8)
Previous PRK, number of eyes (percentage)	12 (15.6)
Indication (cataract/RLE)	29/48
Mean age (Y) at lens extraction ± SD (range)	58.9 ± 5.6 (49,71)
Mean pre-laser SE ± SD (D)	−4.00 ± 2.25 (−10.38, −0.25)
Mean pre-IOL SE ± SD (D)	−0.38 ± 1.33 (−4.13, 2.75)
Mean pre-IOL mean K (D) ± SD (range)	40.66 ± 1.82 (35.45, 45.52)
Mean axial length (mm) ± SD (range)	25.34 ± 1.28 (22.91, 28.95)
Mean power implanted IOL (D) ± SD (range)	20.70 ± 2.46 (15.00, 27.00)

IOL = intraocular lens; LASEK = laser epithelial keratomileusis; LASIK = laser in situ keratomileusis; PRK = photorefractive keratectomy; RLE = refractive lens exchange; SE = spherical equivalent

Corneal Refractive Laser Surgery

Patients who had corneal laser surgery in our clinic were treated with a Zyoptix 217 Z100 excimer laser (Bausch & Lomb, Inc.), using the Keracor 3.21 Dataware nomogram. Corneal laser enhancement for residual refraction after the IOL procedure was done using the standard tissue-saving nomogram (Bausch & Lomb, Inc.).

Intraocular Lenses

An Acrysof Restor SN6AD1 (72 eyes, 93.5%) or SN6AD3 (5 eyes, 6.5%) multifocal IOL was implanted. Both IOLs are single-piece hydrophobic acrylic IOLs with an apodized diffractive multifocal optic that occupies the central 3.6 mm region. Apodization is a gradual decrease in diffractive step heights from the optical center to the periphery. The anterior surface is aspheric.

Surgical Technique

Standard phacoemulsification with the Infinity Ozil (Alcon Laboratories, Inc.) was performed under topical anesthesia by 1 of 2 surgeons (R.L.-G., I.J.E.M.) through a 2.2 mm incision. The multifocal IOL was implanted using the Monarch cartridge and Monarch II injector (Alcon Laboratories, Inc.).

Statistical Analysis

Data were analyzed using SPSS for Windows software (version 22.0, International Business Machines Corp.). The influence of various parameters on the postoperative refractive outcome was evaluated by correlation analysis (Pearson r correlation). Normality was checked with normal probability plots and Kolmogorov-Smirnov and Shapiro-Wilk tests. Depending on normality, a t test or Mann-Whitney U test was used to compare the between-group outcomes. Differences were considered to be statistically significant when the P value was less than 0.05.

RESULTS

The study comprised 77 eyes of 43 patients. Table 1 shows the patients' demographics. Phacoemulsification with implantation of a multifocal IOL was uneventful in all cases.