Phacoemulsification and Implantation of an Accommodating IOL After PRK

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ABSTRACT

PURPOSE: To present a case of phacoemulsification and implantation of an accommodating intraocular lens (IOL) in a patient with cataract formation after previous refractive surgery.

METHODS: A 50-year-old man, who initially had photorefractive keratectomy to correct moderate myopia, developed a cataract in one eye. He subsequently underwent phacoemulsification and implantation of a 1CU accommodating IOL, as he wished to remain spectacle independent.

RESULTS: The patient's distance vision was fully restored. However, accommodative function, which was assessed using subjective and novice objective techniques, was only partially restored.

CONCLUSIONS: Although the accommodating IOL fully restored the patient's distance vision, accommodative function was only partially restored. [*J Refract Surg*. 2006;22:106-108.]

A patient's desire for spectacle independence in the presbyopic age presents a challenge to the refractive surgeon, as there are no definitive treatments to date to restore lens accommodation. Monovision or blended vision with aimed myopia in one eye,[1] full correction of refractive error with scleral expansion implants for presbyopia,[2] and refractive lens extraction with multifocal intraocular lens (IOL) are amongst the accepted options.[3] Accommodating IOLs following refractive lensectomy are now available as an additional option.[4,5] These lenses partially restore accommodation through forward movement of the IOL optic mediated by a contraction of the ciliary muscle, which increases the overall power of the eye.[6]

In this report, we describe a 50-year-old myope who first underwent photorefractive keratectomy (PRK) with the goal of monovision and subsequently had lens extraction with implantation of an accommodating IOL. Postoperative distance and near visual performance and accommodative function were evaluated using a number of subjective and objective techniques.

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CASE REPORT

A 50-year-old man was referred for moderate myopia laser refractive correction. Manifest refraction was −4.00−0.75×45 in the right eye and −2.75−1.00×170 in the left eye, with decimal best spectacle-corrected visual acuity (BSCVA) being 0.9 and 1.0, respectively. Early lens changes in the right eye in the form of posterior subcapsular opacity were noted. Ocular examination was otherwise unremarkable. The treatment options were discussed at length with the patient. As he had excellent BSCVA in both eyes despite early lens changes in the right eye, he elected to have corneal laser refractive surgery rather than lens surgery. Photorefractive keratectomy was performed in both eyes with the aim of full correction in the dominant left eye and undercorrection for the non-dominant right eye. Postoperative recovery was uneventful and the patient was satisfied with blended vision (Table 1).

Ten months postoperatively the patient returned with increased blurring of vision in the right eye. Early nuclear sclerosis and progression of the posterior subcapsular lens opacity were noted. Visual acuity and manifest refraction are shown in Table 1. The patient underwent phacoemulsification and implantation of the 1CU accommodating IOL (HumanOptics, Erlangen, Germany). The IOL power was calculated using the clinical history method and the Holladay-2 and SRK-T prediction formulas.[7] The refractive outcome was satisfactory given the difficulty in IOL power calculation following keratorefractive surgery. Uncorrected visual acuity (UCVA) increased from 0.1 (prior to lens extraction) to 0.6 at 1 week, and to 1.0 at 1 month. Near UCVA stabilized at J3 1 week following lens extraction.

At 6-month final follow-up after IOL implantation, the patient could see 9/10 unaided at distance and J3 unaided at near with his right eye, achieving his goal to be spectacle free. However, a +1.50 D addition was prescribed when quality of near vision was crucial (eg, when reading small print in suboptimal lighting).

Accommodative function was evaluated using a number of techniques. Amplitude of accommodation (ie, dioptric difference between subjective far and near points) was measured with the push up/down test. Forward IOL movement was extrapolated from the change in anterior chamber depth measured using the Axis II A-scan (Quantel Medical, Bozeman, Mont). The patient was asked to read targets at 6 m (distance) and at 25 cm (near) with the left eye. Then biometric (anterior

TABLE 1

Distant and Near Visual Performance for the Right Eye of the Patient

Examination	Distance UCVA	Distance BSCVA	Near UCVA (30 cm)	Near Visual Acuity (30 cm) with Distance Correction	Refraction
At presentation	FC	0.9	J2	—	−4.00 −0.75 × 45
After PRK	0.4	0.9	J2	J4	−1.50 −0.50 × 45
Before lens extraction	0.1	0.6	J5	J6	−2.25 −1.50 × 30
1 week after IOL implantation	0.6	0.8	J3	J2	+0.25 −0.75 × 165
1 month after IOL implantation	1.0	1.2	J3	J3	+0.25 −0.75 × 180
6 months after IOL implantation	1.0	1.1	J3	J3	+0.50 −0.75 × 165

chamber depth, axial length) and keratometric (radii of curvature) data together with the optical parameters of the IOL (in saline: refractive index 1.46; radii of curvature, anterior 11.4 and posterior 11.8; thickness 0.742 mm; and power 20.5 D) were loaded to ray tracing computational software (Zemax EE; Zemax Development Corp, San Diego, Calif) to estimate the change in accommodation secondary to forward IOL movement under ciliary muscle contraction. Results are presented in Table 2, showing a calculated accommodation of 1.10 D at 1 week, decreasing to 1.00 D at 1 month and 0.49 D at 6 months.

Accommodative response induced by a blur-only stimulus was also measured using a purpose-built Badal optometer (with an accommodating target viewed through a beam splitter) mounted on top of a wavefront sensor (Complete Ophthalmic Analysis System [COAS]; Wavefront Sciences Ltd, Albuquerque, NM). This innovative objective technique allows simultaneous evaluation of the wavefront aberration of the eye and its refractive state for a range of accommodative demands.[8] Spherical equivalent refraction was calculated by the defocus and spherical aberration Zernike terms of wavefront aberration, which have been found to accurately predict subjective refraction.[8,9] Mean changes in the refractive state of the eye as a function of accommodative demand are shown in Table 2. Accommodative response as high as 0.44 D at 1 month and 0.30 D at 6 months was achieved.

TABLE 2

Assessment of Accommodative Performance After IOL Implantation

Accommodation Function	1 week	1 month	6 months
Amplitude of accommodation (D)	1.75	1.25	1.00
Forward IOL movement (4.0-D target) (mm)	0.84	0.76	0.37
Accommodation secondary to IOL movement (D)	1.10	1.00	0.49
Accommodation to a 3.0-D target using COAS (D)	—	0.44	0.30

DISCUSSION

As patients who underwent keratorefractive surgery to be spectacle-free get older and reach presbyopic age, the demand for spectacle-free solutions for presbyopia will grow. In this study, we tested visual performance after implanting the 1CU accommodating IOL in an eye that previously underwent PRK. The IOL power calculations led to efficient correction, with distant UCVA being 1.0 (20/20).

Because the true accommodation conferred by the accommodating IOLs is expected to be small,[10] its accurate evaluation is important. Therefore, a number of subjective methods have been created (eg, the accommodometer[4] and focometer[11]), although it is now well accepted that these lead to ambiguous results (ie, recording of pseudoaccommodation) due to residual myopia, astigmatism, depth of focus, and corneal multifocality. Consequently, only when assessed objectively (ie, objective optometry, infrared photorefraction, dynamic streak retinoscopy) or when stimulating methods are used (eg, pilocarpine-induced accommodation or negative lens-induced blur) can true measure of accommodation be achieved.[4,10] It has been suggested, however, that some subjects respond poorly to lens-induced blur[11] and that pilocarpine results in a large forward movement of IOL not encountered with "real" targets, hence overestimating accommodative performance.[12]

We used a number of techniques to evaluate accommodative performance and consequent functionality of near vision after implanting the 1CU IOL. Amplitude of accommodation, as expected, gave the higher values, due to pseudoaccommodative effects. When biometric data were used for computational analysis, accommodation was of the order of 1.0 D at 1 month; when a "real" target at various distances, which preserves proximal cues, was used to objectively assess accommodation, the highest response achieved was of lower magnitude (~0.30 to 0.44 D). The above methods involve monocular viewing, and it is expected that binocularity will further encourage accommodation. Another interesting observation is that the forward movement of the lens, as well as the accommodation achieved, decreases with time (Table 2). This may be attributed to capsular fibrosis,[13] which was not clinically detectable, and/or postoperative positional changes of the IOL itself.

This study reported implantation of an accommodating IOL in an eye with previous excimer laser keratorefractive surgery. The various techniques used to assess accommodation following implantation of the 1CU IOL show variability between subjective and objective measurements. Subjectively, the patient achieved good near UCVA, which left him satisfied, although accommodation was not very effective. However, to truly evaluate accommodating IOLs, it is important to separate true accommodation from pseudoaccommodation. Long-term results and function following posterior capsulotomy are awaited.

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