Outcomes of a new diffractive trifocal intraocular lens

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PURPOSE: To evaluate refractive and visual parameters related to distance, intermediate, and near vision after cataract surgery and the optical quality of a new diffractive trifocal intraocular lens (IOL).

SETTING: Vissum Instituto Oftalmologico de Alicante, Alicante, Spain.

DESIGN: Case series.

METHODS: Patients had bilateral refractive lens exchange and multifocal diffractive IOL (AT Lisa tri 839 MP) implantation. A complete ophthalmology examination was performed preoperatively and postoperatively. The follow-up was 6 months. The main outcome measures were uncorrected distance (UDVA) and corrected distance (CDVA), intermediate, and near visual acuities; keratometry; manifest refraction; and aberrations (total, corneal, internal).

RESULTS: The study comprised 60 eyes of 30 patients (mean age 57.9 years ± 7.8 [SD]; range 42 to 76 years). There was significant improvement in UDVA, uncorrected intermediate visual acuity, uncorrected near visual acuity, CDVA, and distance-corrected intermediate and near visual acuity. The postoperative refractive status was within the range of +1.00 to −1.00 diopter. Total internal aberrations decreased significantly ($P<.001$).

CONCLUSIONS: The trifocal IOL improved near, intermediate, and distance vision in presbyopic patients. The use of 3 foci provided significant intermediate visual results without sacrificing near or distance vision.

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The prevalence of presbyopia[1,2] and the importance of near and intermediate vision in modern society are the main reasons that motivated the development of techniques to compensate for this refractive condition. Examples of nonsurgical procedures are the use of progressive spectacles and contact lenses. Examples of surgical methods[3] include scleral expansion and sclerotomy,[4,5] corneal procedures (presbyopic laser in situ keratomileusis),[6] corneal inlays,[7,8] conductive keratoplasty,[9] monovision,[10] and multifocal intraocular lenses (IOLs).[11,12]

Studies[13–16] report that the loss of reading skills can reduce the quality of life of presbyopic patients. It has been shown that the use of multifocal IOLs can improve uncorrected near visual acuity (UNVA) and uncorrected distance visual acuity (UDVA) and therefore reduce spectacle dependence.[17] Toward this purpose, many designs based on different physics principles have been applied in the manufacturing of IOLs. Basically, 4 types of IOLs are available; that is, refractive, diffractive, refractive–diffractive, and accommodating. Although all can improve UNVA and UDVA, there are collateral effects that should be avoided, such as halos, glare, and loss of contrast sensitivity.[18–21] Moreover, great variability in uncorrected intermediate visual acuity (UIVA) results has been observed with the use of different commercial IOL models. Therefore, improvement in intermediate vision is still needed to increase the level of patient satisfaction.

Many professional and domestic tasks, especially the use of computers, require good intermediate vision. In this sense, the achievement of an intermediate focus in IOLs might help solve this problem. In the present study, bilateral implantation of the AT Lisa tri 839MP (Carl Zeiss Meditec AG), a new diffractive IOL with a trifocal design, was tested. To our knowledge, this is the first study of the behavior of this model and one of the few studies of trifocal IOL technology.[22–25]

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The aim of this study was to evaluate and to discuss the results obtained for distance, intermediate, and near visual acuity; defocus and contrast sensitivity curves; and quality of vision after implantation of the trifocal IOL. Surgical complications during the follow-up and the negative side effects were also evaluated.

PATIENTS AND METHODS

Patients had bilateral phacoemulsification with trifocal IOL implantation for presbyopic correction. All patients were adequately informed and signed a consent form. The study adhered to the tenets of the Declaration of Helsinki and was approved by the local ethics committee.

The inclusion criteria were refractive lens exchange for presbyopia, bilateral surgery, astigmatism of less than 1.0 diopter (D), uneventful surgery, and IOL power between 0.0 D and +32.0 D. The exclusion criteria were previous ocular surgery, ocular disease, complications during surgery, and corneal astigmatism of more than 1.0 D.

Preoperative and Postoperative Examinations

Preoperatively, all patients had an ophthalmologic examination including UDVA and CDVA (4 m, Early Treatment of Diabetic Retinopathy Study [ETDRS]), UNVA and corrected near visual acuity (CNVA) (33 cm), and UIVA and corrected intermediate visual acuity (CIVA) (66 cm) (modified ETDRS for European-wide use for near and intermediate distance recordings, Precision Vision). Other examinations were Goldmann applanation tonometry, slitlamp evaluation, fundoscopy, corneal topography, biometry (IOLMaster, version 4.3, Carl Zeiss Meditec AG), contrast sensitivity measurements under photopic conditions (85 candelas/m^2), (CSV 1000, Vector Vision), optical aberrations (ocular, corneal, and internal), root mean-square (RMS) values and the Strehl ratio (OPD Scan III, Nidek Co. Ltd.). These measurements were recorded with the pupil under cycloplegia with a minimum diameter of 5.0 mm obtained using phenylephrine 10.0%. All measurements correspond to a 5.0 mm pupil. Patients were evaluated 1 and 7 days and 1, 3, and 6 months postoperatively. One and 7 days after surgery, only UDVA, UNVA, intraocular pressure (IOP), and the integrity of the anterior segment were evaluated. The postoperative examination protocol at 1, 3, and 6 months was identical to the preoperative protocol. The postoperative protocol also included visual acuity at 40 cm. Three months after surgery, defocus curves were obtained to characterize the far, near, and intermediate visual function. Defocus curves were obtained using ETDRS charts at 4 m with monocular and binocular vision for each patient; the measurements were performed using distance correction. Lenses from +4.5 to 0.0 D in 0.5 D steps were placed in front of each eye, and the value of visual acuity was recorded. Afterward, measurements were taken using negative lenses up to −4.5 D. This information was represented in a 2-dimensional graphic using Cartesian coordinates (spherical blur in the x-axis and visual acuity in the y-axis). Comparisons of intermediate vision were performed at 66 cm, and comparisons of near vision were performed at 33 cm.

All patients completed a test provided by the manufacturer of the trifocal IOL to evaluate the subjective degree of satisfaction for different tasks. This test is not validated to evaluate the quality of life of the patient before or after IOL implantation. However, it was thought it would be interesting to analyze these results, at least with the purpose of finding correlations between the scores and several visual variables. A clinician registered the scores to the following question: Describe, using a number, the quality of vision for these different tasks. Tasks evaluated were television, theater/concerts, at home, driving at daytime, driving at night (distance vision), cooking, newspaper, computer, and housework (intermediate and near vision). The possible scores were excellent (1), very good (2), good (3), not completely satisfied (4), dissatisfied (5), and very dissatisfied (6).

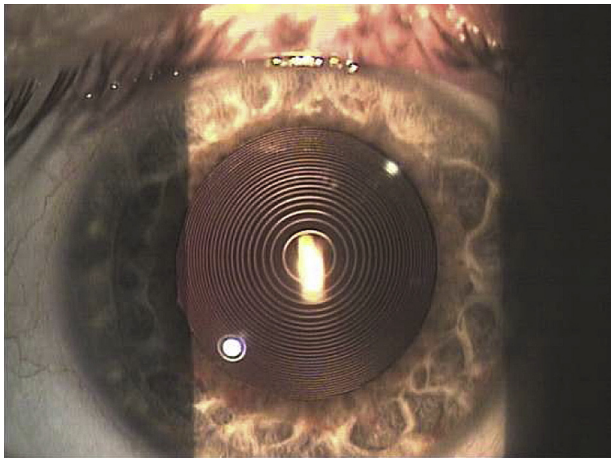

Figure 1. Implanted trifocal IOL.

Surgical Technique

All surgeries were performed by the same experienced surgeon (P.M.) using a standard technique of sutureless

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