Visual Performances With Monofocal, Accommodating, and Multifocal Intraocular Lenses in Patients With Unilateral Cataract

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• PURPOSE: To compare the visual performance of patients with unilateral cataract following implantation of monofocal, accommodating, refractive, and diffractive multifocal intraocular lenses (IOL).

• DESIGN: Prospective nonrandomized clinical trial.

• METHODS: Eighty-seven patients with unilateral cataract were enrolled in 4 groups for phacoemulsification and IOL implantation. Twenty-four patients had monofocal (Alcon Acrysof) (group 1), 21 patients had accommodating (Human Optics 1CU) (group 2), 22 patients had diffractive multifocal (Tecnis ZM900) (group 3), and 20 patients had refractive multifocal (AMO Rezoom) (group 4) IOL implantations. Ages of patients were between 40 and 70. Parameters analyzed at the 18th postoperative month were subjective refractions, monocular and binocular distance, intermediate and near uncorrected visual acuities, monocular distance and near best-corrected visual acuities, monocular distance-corrected intermediate and near visual acuities, stereopsis, visual complaints, and spectacle dependency.

• RESULTS: No significant difference was observed between distance and near best-corrected visual acuities of IOL groups, and between intermediate visual acuities of groups 2, 3, and 4. Groups 3 and 4 had statistically better near vision than the other groups ($P < .05$). No significant difference was observed between near visual acuities of groups 3 and 4. Number of patients with better stereoscopic function, spectacle independence, and complaints of halo in groups 3 and 4 was significantly higher than in other groups ($P < .05$).

• CONCLUSIONS: Multifocal IOLs provide better stereopsis, higher spectacle independence rates, and satisfactory functional vision over a broad range of distances in presbyopic patients with unilateral cataract compared with the monofocal and accommodating IOLs. (Am J Ophthalmol 2010;150:609–618. © 2010 by Elsevier Inc. All rights reserved.)

See Accompanying Editorial on page 593.

Accepted for publication May 19, 2010.

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PRESBYOPIA IN THE CONTEXT OF CATARACT REHABILITATION presents a major challenge for surgeons who perform cataract and refractive surgeries. Several procedures are available including scleral expansion surgery,[1] corneal inlays,[2] zonal photorefractive keratectomy,[3] accommodating intraocular lenses (IOLs),[4] and various types of multifocal IOLs.[5] Surgically created myopic astigmatism[6] and monovision[7] (unilateral myopia) may be used to compensate for pseudophakic presbyopia; however, both near and distance binocular visual function deteriorate with these techniques.

Lack of accommodation in the pseudophakic eye after unilateral cataract surgery may result in varying degrees of aniseikonia and anisometropia, particularly in younger patients who have accommodative capability in the fellow eye. This can compromise binocular vision, particularly in intermediate and near visual acuity. Elderly patients with pseudophakic presbyopia after monofocal IOL implantation are less likely to experience anisometropia and aniseikonia because the healthy fellow eye also needs correction for near vision. However, unilateral monofocal IOLs do not provide adequate depth of focus at distance, intermediate, and near vision and may decrease binocular visual function. Multifocal IOLs allow visual acuity over a wide range of distances and may have an additive effect on binocular vision in patients with unilateral cataract; however, this procedure has drawbacks such as low contrast sensitivity, haze, glare, and decreased night vision.[8,9]

The aim of this study was to evaluate and compare the clinical safety and efficacy of conventional monofocal IOLs, accommodating IOLs, and refractive and diffractive multifocal IOLs in presbyopic patients with unilateral cataract. To accomplish this, we examined monocular and binocular vision at different distances, assessing stereopsis, visual complaints, spectacle dependency, and satisfaction with corrected vision in patients with the various IOLs.

METHODS

THIS PROSPECTIVE NONRANDOMIZED CLINICAL STUDY INcluded 87 patients with unilateral cataract who were scheduled for cataract extraction and IOL implantation between February 2008 and June 2008. Twenty-four patients received a monofocal IOL (group 1), 21 received an

0002-9394/$36.00
doi:10.1016/j.ajo.2010.05.023

accommodating IOL (group 2), 22 received a diffractive multifocal IOL (group 3), and 20 patients received a refractive multifocal IOL (group 4). Patient selection was based on age, and the inclusion criteria were unilateral cataract needing distance correction, Snellen visual acuity of less than 20/32, a healthy fellow eye with no cataract, and a corrected Snellen visual acuity of 20/25 or better, age between 40 and 70 years, and precataract myopia or hyperopia ≤1.5 diopters (D). Exclusion criteria were a history of amblyopia, astigmatism over 1.5 D, mesopic pupil size larger than 6 mm, aniridia, microphthalmos, uncontrolled glaucoma, chronic uveitis, corneal disease (opacities, degenerations, dystrophies), previous ocular surgery or trauma that caused zonular defects, iris and lens capsule defects, previous retinal surgery, and retinal pathology (macular disease, diabetic retinopathy). Intraoperative exclusion criteria were capsular defect and vitreous loss.

The monofocal IOL group received an Acrysof SA60AT foldable hydrophobic acrylic IOL with an optic diameter of 6.0 mm and total diameter of 13 mm (Alcon, Fort Worth, Texas, USA). The accommodating IOL group received the 1CU Accommodative IOL, a foldable, hydrophilic acrylic posterior chamber IOL with an optic diameter of 5.5 mm and total length of 9.8 mm (HumanOptics AG, Erlangen, Germany). This IOL had a refractive index of 1.46, biconvex square-edged optic, and 4 flexible haptics that bend when constricted by the capsular bag after ciliary muscle contraction. The optic was able to move along the anterior visual axis. The diffractive IOL group received a Tecnis ZM900 (Advanced Medical Optics Inc [AMO], Santa Ana, California, USA), a 3-piece silicone IOL with an anterior modified prolate surface and a diffractive posterior surface. This IOL had a 2.85-D add at the spectacle plane. The refractive multifocal IOL group received a Rezoom (AMO) hydrophobic acrylic 3-piece IOL with 5 refractive optical zones on the anterior surface; the first, third, and fifth zones were designed for distance vision and the second and fourth zones for near vision. The aspheric transition zones between these 5 zones were designed for intermediate vision. The lens had a 2.5-D add at the spectacle plane.

Immersion A-scan biometry was used to measure IOL power, and the SRK/T formula was used to make biometric calculations. The A-constants for the Alcon Acrysof, 1CU Accommodative, Tecnis ZM900, and Rezoom were 118.4, 118.1, 119, and 118.4, respectively. The target refraction for these IOLs based on the manufacturer's recommendations were emmetropia, −0.25 D, between emmetropia and 0.25 D, and emmetropia, respectively.

All surgeries were performed by the same surgeon (C.M.). A 3-mm clear corneal tunnel incision was made at the steepest meridian, and capsulorhexis with a 5.0- to 5.5-mm hydrodissection, phacoemulsification of the nucleus, aspiration of the cortical remnants, and IOL implantation into the capsular bag were performed under topical anesthesia. The monofocal IOL was implanted using a Monarch II injector (Alcon); a Deutschmann injector (Deutschmann, Zittau, Germany) was used for the accommodating IOL; and the Unfolder Silver delivery system and Unfolder Emerald delivery system (Abbott Medical Optics, Abbott Park, Illinois, USA) were used for the diffractive and refractive IOL implantation, respectively. Ofloxacin 0.3% and dexamethasone 0.2% eye drops were administered 4 times a day for 3 or 4 weeks after surgery.

Prior to surgery, the corrected visual acuity of the eye with the cataract and the fellow eye were measured, and the uncorrected visual acuity and refractive measurements of the fellow eye were taken.

Follow-up examinations were conducted at 1 and 2 weeks after surgery and then at 1, 3, 6, 9, 12, 14, and 18 months. During each visit, a slit-lamp examination was performed and intraocular pressure was measured using Goldmann tonometry. Eighteen months after surgery, subjective refractions and monocular distance and near best-corrected visual acuity; distance-corrected near and intermediate visual acuity; and monocular and binocular distance, intermediate, and near uncorrected visual acuity were measured.

Distance visual acuity was measured in logarithm of minimal angle of resolution (logMAR) units using an Early Treatment Diabetic Retinopathy Study (ETDRS) chart (Precision Vision, Aurora, Colorado, USA) at 4 m with 100% contrast. Intermediate and near visual acuity were measured in logMAR units with an ETDRS chart at 60 cm and 35 cm, respectively.

Binocular function was evaluated 18 months after surgery using the Titmus test (Stereo Optical Co, Chicago, Illinois, USA). Corrected near vision in the fellow eye was used in stereo testing. Patients wore polarized eyeglasses during the test and held a book at a distance of 40 cm. Stereoscopic measurements were carried out at 2 disparity threshold values: 100 and 40 seconds of arc.

Spectacle dependency for near and distance vision, visual complaints of glare and halo, and patients' overall satisfaction with their vision were determined by questioning the patients. The patients were asked if they experienced halo or glare in their everyday life, and these conditions were illustrated with a picture of a halo and glare. No further questions were asked if the response to the initial question was negative. However, if the response was yes, the patients were asked if the complaints were excessive and if they would like an IOL exchange. The overall satisfaction rate was determined using the generic query, "Are you happy in your daily life with the result of the procedure?" To ensure the patients understood the question, additional clarification was given, such as asking whether their vision was satisfactory while performing their job, daily tasks, and hobbies. If the patient answered yes, no further questions were asked. However, patients who answered no were asked if they were unhappy with the result of their surgery and whether they would like an IOL exchange.