The mechanism of pseudophakic accommodation remains somewhat theoretical. It is postulated that the contraction of the ciliary muscle allows for the relaxation of zonular fibers, which displaces the IOL-capsular bag complex. It is assumed that a redistribution of the ciliary body’s muscle mass during accommodation results in an increase in vitreous pressure that displaces the lens anteriorly. In order to distinguish true pseudophakic accommodation from pseudoaccommodation, an objective measurement of the IOL’s movement or change in position is necessary.

the refractive power of the eye is necessary. Methods to assess pseudophakic accommodation directly include retinoscopy, autorefraction, and wavefront aberrometry. The measurement of the anterior chamber’s depth using ultrasound biomicroscopy or optical coherence tomography can indirectly measure this phenomenon. Experimentally, the clinician can stimulate accommodation by instilling one drop of 2% pilocarpine.

**PSEUDOPHAKIC ACCOMMODATION WITH CONVENTIONAL IOLs**

Vamosi et al² performed a prospective study on 22 cataractous eyes implanted with the three-piece Acrysof MA60BM IOL (Alcon Laboratories, Inc., Fort Worth, TX) to determine the amplitude of pseudophakic accommodation at 3, 6, and 12 months postoperatively. The anterior chamber’s depth was measured by applanation A-scan biometry during the patients’ fixation at 30 cm and again following the instillation of 1% cyclopentolate. The shift in the anterior chamber’s depth was correlated with the amplitude of accommodation. The magnitude of accommodation as measured by the shift in the anterior chamber’s depth increased at each follow-up interval (0.26 ± 0.19 mm at 3 months, 0.39 ± 0.27 mm at 6 months, and 0.57 ± 0.23 mm at 12 months postoperatively). The increase from a mean shift of 0.26 mm at 3 months to 0.57 mm at 12 months was highly significant (P = .00009). The investigators suggested that patients may have “learned” pseudophakic accommodation as time progressed. According to the investigators, the 12-month shift of 0.57 mm in the anterior chamber’s depth correlates with approximately 1.00 D of accommodation in a standard Gullstrand eye model.

**SINGLE-OPTIC, FLEXIBLE-HAPTIC ACCOMMODATING IOLs**

Single-optic, flexible-haptic accommodating IOLs include the Crystalens and the Akkommodative 1CU (not available in the US; Humanoptics AG, Erlangen, Germany). Macsai et al³ compared the visual outcomes and accommodative amplitude of 56 cataract patients (112 eyes) after the bilateral implantation of the Crystalens versus an equal number of monofocal controls for approximately 6 months postoperatively. A single observer performed a masked and randomized postoperative examination on 224 eyes of patients enrolled in the study (pooled data from 10 US surgeons). The silicone Crystalens has a biconvex, 4.5-mm optic and hinges at the plate haptic-optic junction to facilitate movement in the eye. This lens vaults posteriorly within the capsular bag. Macsai et al found that the uncorrected monocular near vision was J3 or better in 90% of eyes with the Crystalens (101 of 112), which was significantly better than in the monofocal controls (13%, 17 of 112) (P < .01). Accommodation as measured subjectively by defocus and near point testing and objectively by dynamic retinoscopy was significantly better in the Crystalens group than monofocal controls (P < .01). Dynamic retinoscopy showed an amplitude of accommodation of 2.42 ± 0.39 D in the Crystalens group compared with 0.91 ± 0.24 D in the control group. Monocular defocus testing revealed 1.74 ± 0.48 D in the Crystalens group compared with 0.75 ± 0.25 D for the monofocal controls. The monocular near point of accommodation was 9.5 ± 3.1 inches for the Crystalens versus 34.7 ± 9.8 inches in the control group. The investigators did not report measurements of the anterior chamber’s depth.

Langenbucher et al⁴ analyzed 23 eyes of 23 patients at 1, 3, and 6 months following cataract extraction with the implantation of the Akkommodative 1CU IOL. The study included a control group of 20 eyes that underwent surgery with various conventional IOLs for comparison. Accommodative range was measured objectively by streak retinoscopy and the anterior chamber’s depth (IOLMaster; Carl Zeiss Meditec, Inc., Dublin, CA). Maximal accommodation was stimulated with 2% pilocarpine. The accommodative response as measured using streak retinoscopy was stable throughout the follow-up period. The mean response was 0.99 ± 0.48 D in the Akkommodative 1CU group at 6 months compared with 0.24 ± 0.21 D in the control group. Unlike streak retinoscopy, which demonstrated a stable accommodative amplitude in the first 6 months postoperatively, the researchers found that the anterior chamber’s depth following the instillation of 2% pilocarpine increased significantly from 1 to 6 months in the Akkommodative 1CU group (0.38 ± 0.14 mm at 1 month and 0.78 ± 0.12 mm at 6 months). They cautioned that the disparity between streak retinoscopy and the anterior chamber’s depth as measures of accommodation in this group of pseudophakic eyes underscores the fact that there is not a single gold standard measure of
Hancox et al. used the ACMaster (Carl Zeiss Meditec, Inc.) to measure the change in the anterior chamber's depth with accommodation in 30 patients. Each patient had one eye implanted with the Akkommodative 1CU IOL and the fellow eye with an Acrysof MA30 monofocal IOL (Alcon Laboratories, Inc.) with a follow-up period of 18 to 24 months. At the final evaluation, the investigators found the mean near visual acuity in the Akkommodative 1CU and the Acrysof MA30 eyes was J10 (e.g., no difference between the two groups). After the instillation of 4% pilocarpine, a slight mean forward movement of 0.220 ±0.169mm was observed in the Akkommodative 1CU group versus a slight backward movement of 0.028 ±0.095mm in the Acrysof MA30 group. The investigators noted that, after longer follow-up than in prior studies (18 to 24 months vs 6 months in the study by Langenbucher et al.), the movement of the Akkommodative 1CU lens within the eye seemed to fade significantly over time. Therefore, although Langenbucher et al. found an increase in accommodative amplitude based on the anterior chamber’s depth from 1 to 6 months, this effect seemed largely lost by 18 to 24 months, according to Hancox et al. Although they concluded that the residual movement recorded was not clinically significant, the investigators suggested that the persistent forward movement of the Akkommodative 1CU within the eye validates its design concept.

DUAL-OPTIC IOls

McLeod et al. designed a dual-optic IOL and used ray-tracing analysis to evaluate the lens’ optical properties. They noted that a high-powered plus optic linked by spring-loaded haptics to a minus-powered posterior lens would produce a greater amplitude of accommodation for a given amount of the optic’s movement than a single-optic system. For example, the investigators used ray tracing in a model eye with a 19.00D single-optic IOL. They demonstrated that an anterior displacement of the IOL by 1mm would change the power of the eye by about 1.20D. By contrast, in a dual-optic system with a 32.00D anterior optic separated by 0.5mm from a posterior -12.00D optic, a 1-mm anterior displacement of the anterior lens would result in an approximately 2.20D power shift of the eye.

Currently in FDA clinical trials, the Synchrony IOL (Visiogen, Inc., Irvine, CA) is a single-piece, foldable, silicone lens with a 5.5-mm, high-powered anterior optic and a 6-mm compensatory minus-powered posterior optic. When implanted, the spring-like haptics are in a resting position beyond the confines of the capsular bag and therefore maintain continuous tension on the capsule. The lens
has been implanted at numerous centers around the world, but FDA data have yet to be released. Dick1 implanted the Synchrony lens in 15 eyes and had no cases of interlenticular opacification at 6 months postoperatively and no intraoperative complications. The eyes had an accommodative range of 0.50 to 2.50D.

THE BOTTOM LINE

Pseudoaccommodating IOLs (including the multifocal Rezoom [Advanced Medical Optics, Inc., Santa Ana, CA] and diffractive Restor [Alcon Laboratories, Inc.]) offer one strategy for reducing spectacle dependence, but truly accommodating IOLs may be another solution. The latter offer the theoretical advantage of improved depth of field while maintaining the optical quality patients enjoy with conventional monofocal IOLs. The long-term refractive stability of these lenses, however, remains uncertain. The initial results with the Crystalex lens in particular but also the Akkommodative 1CU IOL seem promising at 6 months. Eighteen- to 24-month data for the 1CU IOL, however, suggest that the accommodative amplitude may fade over time. Emerging technology for dual-optic IOLs seems promising if long-term safety and stability are proven, because these lenses may have a greater amplitude of accommodation than possible with a single-optic system.

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