Will Accommodating IOLs Ever Work?

With evidence of an accommodative effect of certain lenses now available, there may be future potential for these lenses.

BY JORGE L. ALIÓ, MD, PhD

Given all of the technologies and treatments we have at our disposal to correct refractive errors and treat patients with cataracts, it is a wonder that we have not yet conceived an accommodating IOL design that perfectly mimics the movement of the natural crystalline lens. Many models have come close, providing a reasonable range of focus at all distances by inducing movement and change in shape of the IOL inside the eye. But none can replicate the range of vision we have in our 20s.

The question remains: Will we ever succeed in creating an IOL that reproduces the mechanisms of the ciliary body and crystalline lens? There have been reports of objective and subjective evidence showing the accommodative amplitude of certain IOLs, but, in order to get to the bottom of this issue, we must first review the basic principles of accommodating IOL designs.

LENS PLACEMENT

Historically, IOLs have been designed for placement in one of two locations: the capsular bag or the sulcus. The capsular bag has been the favored location for nonaccommodating IOLs for several decades, but perhaps this is not the best location for an accommodating IOL. Consider the following:

- The capsular bag is the basal membrane of the lens epithelium. Once the crystalline lens is removed—that is, once the capsular bag is empty—it no longer has any reason to exist. With no function and no anatomy to support, fibrosis and atrophy are unavoidable.
- After crystalline lens removal, the zonular-capsular system continue to act as a diaphragm membrane and the ciliary body remains active, meaning that forces still exist in this region (Figure 1).
- The anterior capsule is the structural source of kinetic energy in the capsular bag, generating the axial or centripetal forces that generate accommodation; the posterior capsule plays a minimal and insignificant role in this function.

For these reasons, the capsular bag seems to be an inadequate location for accommodating IOLs, mainly due to the fibrosis and atrophy that occur after crystalline lens removal. Alternatively, the forces that continue to be generated by the zonular-capsular system suggest that this location can be better used to support accommodating IOL designs.

In order for accommodating IOLs to have a future in cataract surgery and presbyopia correction, we must determine, once and for all, the best location for these lenses.

IN THE PIPELINE

There are four accommodating IOLs in the pipeline, of which two (FluidVision; PowerVision, and Sapphire; Elenza) are designed for capsular bag placement and two (DynaCurve; NuLens, and Lumina; Akkolens/Oculentis) for sulcus placement.
**FluidVision IOL.** The hollow body and haptics of this intracapsular bag IOL are filled with silicone oil (Figure 2). When the oil moves from the haptics to the optic, the optical power of the lens increases. This IOL can be implanted through a 4-mm incision. In a pilot study in 20 patients, there were no reported complications, with good near and intermediate visual acuities.

**Sapphire.** This electronically activated IOL reportedly achieves accommodation without actual movement. It is a monofocal static IOL made of a hydrophobic material. It has an aspheric central optic for distance and intermediate vision and an additional electroactive diffractive liquid crystal section for near vision (Figure 3). Micronano-electromechanical systems in the lens detect physiologic triggers of accommodation, and on-board processors and algorithms control the power sequence. With this pseudoaccommodation, an additional 2.00 to 2.50 D of power are provided for near vision. The power cells of this IOL are recharged weekly with an inductive charging element, and it is designed to have a 50-year lifetime.

**DynaCurve.** Similar in concept to the FluidVision but working in the sulcus, this IOL achieves accommodation through use of a fluid or gel to change its shape (Figure 4). In theory, this lens could provide up to 10.00 D of accommodation. The DynaCurve IOL is implanted in front of the collapsed capsular bag, which is used as a component of a dynamic diaphragm. When this capsular diaphragm activates the lens’ components (a small chamber filled with silicone and a piston-like element, and a flexible membrane), the lens changes shape.

We were initially involved in a pilot study for this lens, in which it was implanted in the worse eye of 10 patients with age-related macular degeneration and cataract. By 12 months, near UCVA and BCVA in the treated eyes had improved, and distance visual acuity was not compromised.

Further studies in normally sighted eyes were conducted in Peru and Mexico, and results will be reported in the near future.

**Lumina.** This two-element varifocal lens is also designed for sulcus placement. It changes focal powers when its elements shift in the plane perpendicular to the optical axis. Again, we are involved in a pilot study in which 51 implantations of this lens are being compared with 22 of a monofocal lens (AcrySof Restor; Alcon).

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Evidence of accommodation with this varifocal lens was evaluated using objective measurements with the WAM-5500 (Grand Seiko) and defocus curves (Figure 5). Results of this study indicate that the Lumina successfully restores variable amounts of astigmatism and provides accommodative performance of 1.50 to 6.00 D.

CONCLUSION

With a handful of accommodating IOLs already commercially available and several more in the pipeline, we are likely to see a growth in the potential of these technologies over the next few years. Implantation of an accommodating lens within the sulcus seems to offer various advantages, and reported outcomes are most promising for the Akkolens Lumina. In any case, it may take a while before we have a lens that achieves true accommodation; however, researchers are honing their research to determine what type of design is best suited to mimic the performance of the crystalline lens.

Jorge L. Alió, MD, PhD, is a Professor and the Chairman of Ophthalmology at the Miguel Hernandez University, Alicante, Spain, and the Medical Director of Vissum Corporación in Spain. Dr. Alió states that he is a consultant to and clinical investigator for the Elenza, Nulens, and Akkolens projects. He may be reached at tel: +34 96 515 00 25; e-mail: jalio@vissum.com.