MEDICONCEPT

New Technology IOLs

Robert M. Kershner, MD, MS, FACS
President and CEO
Eye Laser Consulting
Boston, Massachusetts

INTRODUCTION

Dr. Kershner's first of four lectures focuses upon research and advances in intraocular lens (IOLs) technology. The future of IOLs is bright indeed. According to Dr. Kershner there is a lot of interest in improving visual function, protecting the eye, making it possible for a patient to see better without corrective lenses, in restoring the vision of youth and for the first time in providing patients with the ability to see beyond the capabilities of the natural eye.

THEN, NOW, AND THE FUTURE

Sir Harold Ridley invented the first IOL over fifty years ago and another 30 years passed before it was widely accepted. Dr. Kershner showed an historic segment of 16-millimeter film of Dr. Ridley implanting the early Ridley lens into a patient's eye in 1949**.** In 1976 phacoemulsification took three hours to complete. Cataract surgery in 1980 required four hands, 45 minutes of general anesthesia, and a five-day hospital stay, with aphakia as the result. The aphakic spectacle or contact lens was once the mainstay of treatment for the aphakic patient following cataract surgery. Today, ophthalmic surgeons are able to restore clear, uncorrected vision for cataract patients with an implanted lens. The procedure takes minutes and the patient returns to regular activities without interruption. We have come a long way in a short period of time.

Dr. Kershner asked rhetorically, "Where are we going to go in the next 25 or even 50 years?" There will be new optic designs, presbyopic and phakic IOLs, corneal implants, microprocessor controlled miniaturized optical systems that allow everything from telescopic vision, to seeing wavelengths of light that are imperceptible to the human eye and ultimately to a cure for blindness.

TINTED IOLS: ARE THEY PROTECTIVE?

Dr. Kershner discussed the issue of tinted lenses and whether they are of benefit. Blue-blocker glasses worn during the day block out the predominantly blue wavelength of light and in bright sunlight, provide comfort, but they must be removed at dusk. The FDA found no evidence to support a protective function by blocking the blue light wavelength in an IOL. Scotopic luminosity efficiency of the human eye is directly dependent upon that very wavelength of light that blueblocker lenses, such as the AcrySof Natural, are designed to filter. If there is enough filter to protect the retina, then one would expect both color distortion and loss of contrast with this lens at night. Patients may not

complain, because they have no frame of reference however, their contrast will be greatly reduced at night; a significant concern for elderly patients.

IMPROVED IOL OPTICS

Since the original design by Ridley, the optics of biconvex spherical IOLs have remain unchanged. Researchers are now looking at how their optics can be modified. Surgeons have the ability to apply technology from refractive surgery and wavefront to IOLs. Dr. Kershner used the Tecnis modified prolate IOL optic, as an example of a new technology optic designed to improve visual quality and functional visual performance. This lens assumes the average corneal spherical aberration in over 96% of patients and applies its wavemap to neutralize the aberration on the IOL surface.

Spherical Aberration

High order aberrations can be measured, however for all practical purposes, they still comprise only a small percentage of the total aberrations of the eye. Spherical aberration, on the other hand, is the number one concern to the cataract patient, it is what is responsible for image degradation, the need for increased illumination and the loss of contrast perception.

ASPHERIC IOLS

Currently, IOLs are designed as spheres. They do not correct spherical aberration and, in fact, contribute to it. Why then not create an aspheric lens, much like today's sophisticated cameras that eliminates spherical aberration that reduces contrast? The concept was first attempted over 25 years ago by ORC and was unsuccessful. Simply making the IOL aspheric only reduces aberration within the IOL and does nothing to enhance the optical system. Without taking into account the cornea, the most powerful refracting surface of the eye, it simply cannot work. What makes the Tecnis IOL unique is that it is designed specifically for the optical system of the eye.

PHAKIC IOLS

Phakic IOLs open an exciting area for ophthalmic surgeons. They allow ophthalmic surgeons to offer the optical quality of an IOL to their refractive patients. Dr. Kershner feels that the days of correcting refractive error through "cutting and burning of the cornea" are numbered, and that IOLs will soon be the treatment of choice to correct refractive error within the eye.

IOLS AND PRESBYOPIA TREATMENT

Dr. Kershner believes that the conquest of presbyopia is the next and most important frontier. Presbyopia occurs when the human lens loses it's ability to accommodate. When the ciliary body contracts, the zonular apparatus loosens, and the lens takes on a more globular shape by movement and increasing curvature of the anterior surface. Fifty

percent of North Americans are presbyopic, making this a more commonly encountered problem than cataracts. Glasses and contact lenses inadequately address the issue.

The currently available presbyopic or bifocal IOLs haven't gained much acceptance for several reasons. Standard multifocal IOLs with their near and far vision design in one optic have an associated and undesirable drop in contrast. To have lenses that work properly the surgeon must ensure accurate biometry, astigmatism correction, and minimize PCO.

Presbyopic lens exchange can be accomplished with any of the five available presbyopic IOLs. The AMO Array, SA-40N, has the longest experience in patients, it is a progressive refractive IOL with multiple zones, is intermediate dominant, and works well in select patients. AMO has designed the next generation lens called the ReZOOM, which addresses many of the concerns with single optic presbyopic IOLs. It works well for distance, near and everything in between. The Alcon ReSTOR is a diffractive optic that is near dominant and as such is not for every patient. The Tecnis multifocal, Dr. Kershner believes, is a tremendous advance because it addresses the two most important issues with monofocal/bifocal optics on a single lens, decreased contrast, and aberrations induced by splitting the light. The Tecnis is a posterior defractive multifocal IOL with a modified prolate anterior surface that functions to improve contrast. Therefore, the anterior surface neutralizes spherical aberration and the posterior surface provides the additional power range for near. A look at the rate tracings shows two distinct points of focus for near and far. Dr. Kershner compared the ReSTOR lens with the Tecnis using an average corneal eye model and Air Force resolution targets. Image quality was superior for near and far with the Tecnis multifocal **(Fig. 1)**. The eyeonics Crystalens is a "moveable" accommodating 4.5mm optic IOL that is purported to allow approximately 1.2D of accommodation. Unfortunately, most studies have failed to demonstrate long-standing and reproducible movement of the IOL that would explain any "accommodative" advantage.

LENSES OF THE FUTURE

The future of eye care goes from functional to fantastic. While prototypes of future lenses are currently in various stages of development, Dr. Kershner cited examples as the Vision Care implantable miniature telescope for macular degeneration. "This is the bionic eye" said Dr. Kershner, an IOL that magnifies vision centrally, and is currently in Phase III studies. Other innovations are on the way. One "smart lens" is made of a thermodynamic material, and can be rolled up into a little tube, which is then slipped through a half-millimeter incision and then, as it hydrates, expands into the capsular bag. Calhoun Vision is developing a light-adjustable lens that will be activated by a wavelength of ultraviolet light to adjust postoperative power. The surgeonmay be able to tailor a patient's refractive outcome, correct astigmatism, neutralize wavefront aberrations and potentially, add power to the lens for reading.

Other concepts include dual IOLs connected by a hinge which, upon accommodative effort, the anterior lens will move with respect to the posterior lens for the patient to read. Assuming it could work, the IOLs could be properly aligned, the capsular bag would need to remain clear and one lens could move significantly to induce a power change, the prediction is that this IOL could provide about 3.5 diopters of accommodation.

Another lens was inspired by the Merganser, a marine bird whose diet consists solely of fish. It is capable of spotting a fish from a half-mile up, dives into the water to retrieve it and is able to see it clearly while underwater. It accomplishes this by bulging it's natural lens through it's pupil to increase accommodation by 35 diopters. A new lens was developed in Israel to capitalize on this concept. It is a hydraulic with a silicone gel-filled piston which upon accommodative effort will increase its power to render almost 30 diopters of accommodative potential.

IOLs are going to address glaucoma and retinal disease. The Acritec lens will a monitor intraocular pressure on an ongoing basis with an integrated microchip and built-in sensor. The prospect of implanting IOLs that will monitor a glaucoma patient's progress with treatment and would alert the physician to pressure rises is, in Dr. Kershner's words, "Very exciting".

NIP ICO IN THE BUD

The sealed capsular irrigation device is one way to deliver a clear capsule required by the new "accommodating" IOLs. Eliminating posterior capsular opacification (PCO) or more appropriately, IntraCapsular Opacification (ICO) is a goal of every IOL surgeon. Dr. Kershner showed work he had done on sealed capsular irrigation. He feels that thorough hydrodissection is the best way to eliminate ICO before it forms. This is accomplished by going under the incision with a curved cannula and irrigating the capsular subincisional cortex. This loosens the cells and irrigates them out at the beginning of the case, making it easier to aspirate the cortex later. The device which can accomplish this is the Perfect Capsule, invented by Anthony Maloof of Australia. It is made of silicone and passes through a standard phaco incision. A large channel allows instruments to pass, a smaller channel is attached to an aspiration syringe **(Figure 3)**. Once in place, on top of the capsulorrhexis irrigation with distilled water ruptures the lens' epithelial cells. To illustrate the procedure's impressive results, Dr. Kershner showed a slide of an eye at six months post-lens implantation **(Figure 4)**. He also provided a Web site address for those interested in finding out more about the device, manufactured by Milvella at http://www.milvella.com.

Fig. 1. The latest advance-Tecnis Multifocal IOL

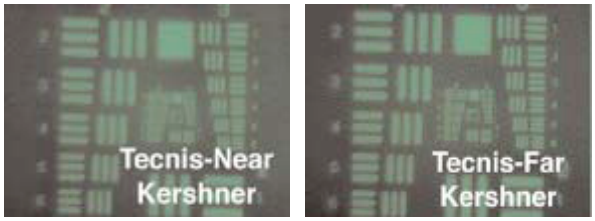

Fig. 2 Tecnis Multifocal imaging with AFS Resolution Targets for near and far.

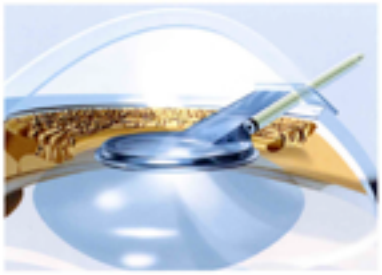

Fig. 3 Perfect Capsule sealed capsular irrigation system

Fig. 4 Eye 6-months post-lens implantation following one minute of irrigation.