IOLs are the Future

The pipeline is flush with innovation

By Rochelle Nataloni
Contributing Editor

There are close to 2,000 intraocular lenses of one sort or another in the worldwide market, according to ophthalmologist and medical device development consultant, Robert M. Kershner, MD, MS, FACS and yet the literally endless pool of potentially correctable presbyopes makes research and development into new IOLs an investment worth making. Venture capitalists and ophthalmic device manufacturers are putting their money where their eyes are, and are reinvigorating a market that a decade ago threatened to languish in a sea of reimbursement woes. “The fact is,” says refractive surgery veteran and fledgling IOL developer, Lee Nordan, MD, “you cannot correct presbyopia adequately on the cornea. IOLs are the future.”

That said, this article focuses on the IOLs that are in development -- whether they’re on the precipice of FDA approval or merely a glimmer in the eyes of the bright minds that conceive them or a notation on the profit and loss statements of the forward-thinking companies that have the vision to license them. “It’s a vast field and a deep chasm, but the reality is it can be distilled into palatable segments,” says Dr. Kershner, who teaches a course on new technology IOLs to fellow ophthalmologists.

The IOL continuum

IOLs in the pipeline represent a continuum of the ground-braking lenses that are already out there reshaping the face of ophthalmology. AMO’s Tecnis as well as the Array and ReZoom; Alcon’s AcrySof HOA aspheric optic, as well as its ReStore lens; Bausch & Lomb’s SofPort AO and Eyeonics Crystalens have laid the foundation for tomorrow’s dual-optic, deformable and injectable polymer IOLs as well as for the next generation of single optic phakic and aphakic lenses.

Eyeonics has taken its Crystalens a step further with a new version called the SE System. This version extends the square edge 360 degrees around the entire IOL to help maintain the capsular bag. Additionally the need for cycloplegia has been eliminated, and the lens has been validated for use with the STAAR Indigo Injector System, enabling the IOL to be inserted via a smaller, sub-3-mm incision. “We changed our protocol because we found that cycloplegia is not necessary. This is really a huge help to both surgeons and patients, because it simplifies the regimen,” said Kathy Kelly of Eyeonics.

Alcon is focusing on combining the individual benefits of each of its currently available IOLs into lenses that will provide the greatest range of vision without glasses or cataract patients. For example, in March of this year, Alcon gained FDA approval of the AcrySof ReSTOR lens in a clear version, and this was followed by approval of the Natural (blue light filtering) version of the

lens in August. The company is now actively working on incorporating an aspheric design into this lens, and ultimately plans to add a toric feature that will address pre-existing astigmatism.

Alcon also recently gained approval of the AcrySof Toric IOL in a clear version, and will launch it in the spring of 2006. “The main benefit of the AcrySof Toric IOL is that the acrylic material allows it to demonstrate excellent rotational stability with minimal post surgical rotation,” says Richard J. Mackool. “This leads to a large and predictable reduction in the amount of residual refractive astigmatism, which significantly improves uncorrected distance visual acuity. In fact, the approved label for this states that it significantly increases spectacle independence for distance vision.”

STAAR’s posterior chamber Visian ICL, approved for use in the European Union and in Korea and Canada recently received FDA notification that the lens was ‘approvable with conditions.” Those conditions have been met, according to STAAR representative Darcy Smith, and the final approvable letter was expected ‘any day’ at press time. Subject to premarket approval, the refractive phakic implant is placed in the posterior chamber to correct myopia of –3 to –15 D with astigmatism –2.5 D at the spectacle plane, and the reduction of myopia in adults with myopia ranging from –15 to –20 D with astigmatism –2.5 D at the spectacle plane. The lens also can be used to correct myopia in patients age 21 to 45 with anterior chamber depth of 3 mm or greater, and a stable refractive history within 0.5 D for 1 year prior to implantation.

In the meantime, STAAR recently launched its newly designed Three-piece Collamer lens. The new design includes polyimide haptics and incorporates a square continuous contact edge, reducing the potential for posterior capsule opacification, as well as glare. The lens is paired with the ONYX injector and cartridge, which facilitates implantation through a 2.8 mm incision.

In the pipeline

Intriguing IOLs in development include AMO’s Multifocal Tecnis lens. “One of the problems of multifocal IOLs is their loss of image contrast. Imagine having a lens optic that has been shown to improve contrast sensitivity married to a multifocal lens to neutralize the loss of contrast. That’s essentially what the Tecnis Multifocal IOL does,” says Dr. Kershner. “I’ve reviewed optical bench studies on this lens and there’s no question -- the mechanical eye model doesn’t lie -- the image quality is excellent for both near and far.” This lens is available just about everywhere except the U.S. Dr. Kershner predicts FDA approval isn’t more than a year away. Dr. Kershner isclinical professor of ophthalmology, University of Utah School of Medicine, John A. Moran Eye Center in Salt Lake City, Utah, and President and CEO of Eye Laser Consulting in Boston.

David F. Chang, MD, is working with two innovative IOLs in the pipeline that are as different as they are the

same: Visogen's Synchrony and Medennium's Smart IOL. While their mechanism of action is disparate, they share a goal that is common to the majority of developing IOLs: eradication of the symptoms of presbyopia.

Visiogen's Synchrony, of which Dr. Chang is the medical monitor, is according to him, a truly accommodating IOL that should have several advantages over a multifocal IOL. "In addition to avoiding the haloes and contrast sensitivity loss inherent in a multifocal optic, the lens does not produce a single fixed near point of focus," he says. "Instead, Synchrony may allow the patient to adjust their focus along the entire continuum of far, intermediate and near distances." The Synchrony is a single piece dual-optic IOL. Dr. Chang describes its design and mechanism of action as such, "The refractive shift produced by any optic movement is proportional to the dioptric power of the lens. Therefore, the anterior moving optic is a 34 D (+) lens in order to amplify the near shift produced by its forward movement. The rear optic is a minus power lens that is varied in order to achieve the net individual power required for emmetropia. The design relies upon the Helmholz theory of accommodation whereby ciliary muscle contraction reduces zonular tension, allowing the capsular bag to become lax. This allows the spring-like connecting struts to push the anterior optic forward." Ultrasound Biomicroscope (UBM) imaging has confirmed that the front optic does move in the human eye, he says. Clinical trials are ongoing in Europe and South America, and the US FDA trial is scheduled to begin within in the next six months. Dr. Chang is a clinical professor of ophthalmology at the University of California, San Francisco.

Another dual optic accommodative IOL that reportedly holds a great deal of promise is the Sarfarazi elliptical IOL, which Bausch & Lomb has licensed. Comprised of a minus-powered optic positioned posteriorly to a positive-powered optic it is joined by compressible bridges. This innovative lens is being implanted overseas, but is still in the feasibility stage here at home.

Dr. Chang is also working with Medennium's Smart IOL, an injectable polymer lens. "The concept is based on developing a bag-filling IOL in order to allow the ciliary muscle to resume control of lens shape alteration," says Dr. Chang. "This, too, [like the Synchrony] would produce focus along the entire accommodative range." To meet this goal, many researchers have worked on formulating a gel that could fill the emptied bag and remain flexible, Dr. Chang pointed out. "However, this approach creates many new challenges: How much gel does one inject? How does one control the net resulting lens power? How does one seal the capsulotomy, and can a dense cataract be removed through a micro-capsulorhexis that would be most compatible with injectable gel technology?," Dr. Chang said. The final challenge, he noted is, "How

does one produce a precise optical shape with this method?"

The advantage of the Smart IOL, according to Dr. Chang, is that the hydrophobic acrylic lens can be manufactured to precise optical specifications, including power and anterior and posterior curvature. "However, thanks to its unique thermoplatic properties, it can then be reconfigured into a thin rod that can be implanted through a phaco incision. After implantation, warming to body temperature causes the shape to transform back to its original designed configuration which will completely fill the capsular bag. One theoretical advantage of this design is that it is compatible with current phaco methods, and a standard sized capsulorhexis," he explained. The Smart IOL has been implanted into cadaver eyes, but must undergo further testing before clinical trials can begin.

Alcon is also researching mechanically accommodative IOL designs. "The successful development of mechanically accommodative lenses will have to overcome two fundamental challenges: predictability of accommodative effect and sustainability of visual performance," says, Alcon's vice president, surgical products research and development, Robert J. Stevens. "Both of these issues are the result of physiological variability across the patient pool and over time with individual patients. Our product research and development approach is designed to minimize the impact of physiological variability to improve predictability of accommodative effect and sustainability of visual performance," he explained.

Alcon also has a phakic lens in development. This lens is an anterior chamber angle-supported lens that has shown excellent visual results in early clinical studies, according to Stevens. "We are further along with the approval process for this lens in Europe, than we are in the U.S," says Stevens. "We think this lens will perform well and be an option for refractive surgeons when dealing with their highly myopic and hyperopic patients." This lens is likely to be available in Europe by late 2006 or early 2007.

Thinking 'outside the bag'

Dr. Kershner says the ideal IOL would be a single optic device that could change powers, and suggests that the ultimate 'answer' lies in the form of a deformable lens. One such device, the NuLens Accomodating IOL is in development by NuLens, Inc. (Herzliya Pituach, Israel) This IOL is reportedly the first to truly accommodate by changing its power rather than changing its position in the eye. The design concept incorporates the use of a gel-filled piston in the capsular bag, and breaks completely from conventional thought with the placement of the IOL in the ciliary sulcus rather than the capsular bag. "It's the capsular bag that moves the lens," explains Dr. Kershner. The NuLens has been shown to work in primates. The product is poised to enter U.S. clinical trials within the year.

AMO is working on a deformable lens in conjunction with QuestVision. The companies entered into a one-year research and evaluation licensing agreement and are working on a “shape-changing optic to provide accommodation, rather than an axial movement used in single- or dual-optic alternatives," AMO President and CEO Jim Mazzo, said in a press release.

Another deformable IOL with excellent potential, according to Dr. Kershner, is PowerVision’s FluidVision IOL. “This lens has an optic that has a deformable surface, but the deformation of the surface is very closely controlled by a hydraulic. There are reservoirs in the IOL’s haptics and in response to contractions in the ciliary body these reservoirs dump their hydraulic fluid into the center of the lens which then deforms the anterior surface by a predictable and controlled amount to add additional power for near vision,” Dr. Kershner explained. Louis D. "Skip" Nichamin, MD, reported on this lens at the annual meeting of the American Society of Cataract and Refractive Surgery, saying modeling studies demonstrate that by harnessing natural forces in the eye, the FluidVision should be able to create an accommodative range of up to 10 D, and that it is possible that the first human eye procedures will be performed in late 2006. Dr. Nichamin is medical director of the Laurel Eye Clinic in Brookville, Pa.

Refractive surgery veteran Lee Nordan, MD, is championing the Vision Membrane lens, an anterior chamber phakic IOL in development by Vision Membrane Technologies Inc., of which he is president and CEO. “What’s unique about this lens,” says Dr. Nordan, “is that it is the same thinness for all powers. The beauty of this is that the way it sits in the anterior chamber is basically a constant, and regardless of the power there’s the same amount of clearance from the endothelium,” he explained. The lens' patented multi ordered diffractive optics (MOD), provide the benefits of diffraction – near and far vision – without the drawbacks -- chromatic aberrations. “We think we have something here. This is really next generation technology in that we can correct presbyopia but do it in conjunction with correcting distance vision as well. I’m not saying we’re going to wipe out presbyopia but we can eliminate the symptoms,” he said. Dr. Nordan expects to start a CE trial within the next three to six months. “We’re in a proof of concept phase. We’ve implanted seven of the lenses [overseas] and one year postoperatively they look excellent,” he said.

There’s general consensus that the rewards of microincision IOL implantation are worth reaping. Innovative developing IOLs that lend themselves to that goal include the ThinOptX and Lenstec’s Tetraflax. The Tetraflex is an acrylic, square-edged, one-piece microincision accommodating lens with equiconvex optics. Unique haptics and a 5-degree anterior angulation reportedly enable the lens to move forward during the accommodating process. This IOL is in clinical trials in Europe.

The ThinOptX IOL takes the microincisional label to a whole other level, says Dr. Kershner, because it is infinitesimally thin. “The thin optic is created through the use of the Fresnel Prism optical design, and in so doing creates an optic that has no central thickness to it. It’s very thin and flexible like a sheet of cellophane so it can be rolled up very tight and injected in the eye through less than a 1-mm incision,” said Dr. Kershner.

Another truly innovative and potentially groundbreaking IOL is Calhoun Vision’s Light Adjustable Lens, a three-piece IOL, made of a photo-sensitive silicone material. The unique property of this lens is that once implanted its power can be titrated through the use of UV beams from a light delivery device. Arturo S. Chayet, MD, is working with the lens inMexico.

The ‘Holy Grail,’ says Dr. Kershner is an IOL that will change focus, have the optical quality of a standard monofocal lens and provide near and distance vision all in one package. Once that ideal is achieved, he adds, the challenge will be to get it to work *inside* the eye.

Note: Dr. Kershner is President and CEO of Eye Laser Consulting, Boston, Massachusetts, he can be reached at *Kershner@EyeLaserConsulting.com*