Improved options for presbyopes in the near and distant future

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The recent availability of new multifocal and accommodative IOls together with improvements in the techniques and technology of cataract extraction have already transformed what was once a treatment for advanced cataracts into a procedure that can now be used electively in the early stages of presbyopia, according to Dr Fine.

"Cataract surgery has had improved outcomes through lower energy, smaller incisions, and adjunctive astigmatic techniques. As a result of its increased accuracy and safety it has undergone a natural evolution into refractive surgery," he said.

In fact, refractive lens exchange is the fastest growing segment of ophthalmology practice in the US and its volume has doubled each year for the past several years, he pointed out. Moreover, refractive lens exchange is free of many of the restrictions of corneal procedures such as LASIK and surface ablation. It can therefore be used for high hyperopes and high myopes. In addition, refractive lens exchange not only leaves the spherical aberration of the cornea relatively untouched, it can compensate for it in a stable and predictable manner with aspheric lenses.

"Any alterations in the cornea for refractive purposes will be compromised by changing spherical aberration in the crystalline lens as the patient ages. Refractive lens exchange addresses all components of patients’ refractive errors including presbyopia and will be the dominant refractive procedure," Dr Fine said.

Newer multifocals provide higher rates of spectacle independence

IOls for refractive lens exchange that are currently available in the US include two multifocals, the ReZoom (AMO) and the ReSTOR (Alcon), and one accommodative IOl, the Crystalens (Eyeonics Inc.). Studies indicate that the three lenses provide greater spectacle independence than the older Array lens, Dr Fine said.

In a study he and his associates published five years ago, 44 per cent of their patients with the Array lens were spectacle independent and those patients were at least 20/25 and J 2 at near. By comparison, in studies with the ReSTOR lens 80 per cent to 85 per cent of patients achieve spectacle independence. In most studies with the ReZoom lens spectacle independence has varied from 60 per cent to 85 per cent.

Three-year results with the Crystalens show that 73 per cent are 20/25 or better at near and about the same percentage are spectacle independent. However, there was a 10 per cent rate of enhancement among hyperopes, because of the difficulty of predicting the postoperative position of the lens in the eye with precision.

"It was thought that the lens moved in the eye and if that was the case, the more hyperopic the patient, the greater the amplitude of accommodation. We would not expect good results in high myopes but there’s new data that show it’s really deformable optics that give it its near accommodation," he added.

Dr Fine added that results with the Crystalens are likely to improve with a new design of the IOl that has a 5.0mm optic and appears to provide an additional 1.0mm of accommodation.

Widening options for RLE

Dr Fine noted that there are also several other multifocal and accommodating IOls that are currently in FDA clinical trials, including AMO’s Tecnis Multifocal IOl and Visiogen’s dual-optic Synchrony IOl, both of which have received the European CE Mark.

The Tecnis multifocal is a silicone IOl which has a diffractive posterior surface that provides multifocality with a near add of 4.0 D. Like the Tecnis monofocal IOl, it also has a prolene anterior surface to compensate for the positive spherical aberration of the cornea. Investigators outside of the US have reported excellent results with the lens, Dr Fine said.

The Synchrony IOl is also in a Phase III US clinical trial. The lens has a 5.5mm +38.0 D anterior optic and a 6.0mm variable low-minus-powered optic. The IOl is designed to fill the capsular bag and its optics are connected by a spring mechanism that pushes the optics apart when the ciliary muscle contracts and the zonular fibres relax. During non-accommodation, the tensioning of the zonular fibres flattens the capsular bag and, as a consequence, compresses the two optics back towards each other.

Clinical studies with the IOl indicate that it can provide very good binocular uncorrected distance visual acuities and that reading speeds with the lens are comparable to those achieved with the ReZoom or ReSTOR.

Further down the pipeline are IOls that use innovative technologies such as deformable optics, gravity-dependent designs and injectable polymers that fill the capsular bag.

Among accommodating IOls employing deformable optics is the NuLens accommodating IOl and Power Vision’s “Fluid Vision IOl.”
The NuLens IOL consists of two rigid PMMA plates that enclose a flexible polymer. During accommodation the pressure from the vitreous against the posterior plate forces the soft optic material to assume an increased anterior curvature as it is pressed through a circular aperture in the anterior plate. In a pilot clinical study 10 patients implanted with the lens were able to achieve 10 dioptres of accommodation at three months' follow-up.

The Power Vision IOL incorporates new "applied micro fluidic" technology in a single-piece IOL. Upon accommodative stimulation, an actuator triggers microscopic pumps to move fluid from a peripheral reservoir to the centre of the lens, thereby altering its radius of curvature and increasing its optical power. As accommodation relaxes, the fluid is pumped back to the peripheral reservoir and the lens returns to its distance focus.

Another accommodating IOL, the LiquiLens™ (Vision Solution Technologies), uses fluids in an entirely different, gravity-dependent way to achieve accommodation. The optic of the lens contains two immiscible fluids of different refractive indices. When gazing forward the high refractive index sits above a fluid low refractive index, and provides emmetropia at distance. However, when the gaze is turned downward there is a redistribution of the fluids so that the high refractive index fluid will flow into the pupillary space, providing a three-fold-and-above magnification for near focus, Dr Fine explained.

"The accommodative mechanism of action is 100 per cent gravity-dependent; it is the only lens that functions in this way. It is ready to move to prototype stage and detailed engineering drawings have been reviewed with manufacturers," he said.

The SmartIO L (Medennium) offers promising capsule-filling approach. The thermodynamic, hydrophobic, acrylic, injectable, and potentially accommodating IOL has the same dimensions as the average human crystalline lens, and yet is injectable through an incision of 3.0mm or smaller. Prior to implantation the lens can be converted into a 2.0mm rod at room temperature. Once inside the capsular bag, the lens returns to its original dimensions in response to the patient's body temperature.

Another IOL in the early prototype stage uses pixelate optics and is carried inside a carrier IOL. An electric charge, generated by a battery the size of capsular tension ring, causes the pixels to increase their index of refraction, providing a plus power of 4.0 D. For focusing, the lens will either use an optical recognition system, like that employed by digital cameras, or will respond to electrical impulses from the ciliary body.

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