Light adjustable IOLs

New paradigm that will ultimately disrupt the field of refractive IOL surgery

LOS ALTOS [ah] – To overcome the multiple obstacles of refractive IOLs, light adjustable IOL technology could be a valuable solution.

The relatively flat growth in refractive IOL implantation worldwide is indicative of the continuing challenges that cataract surgeons face in meeting the refractive goals and expectations of their patients. These challenges make preoperative counseling time-consuming and stressful for both patients and their ophthalmologists. However, rushed or ineffective communication risks increasing postoperative dissatisfaction and chair time. Although cost is obviously a potential barrier, there are other important obstacles that fall into one of three categories.

Barriers to Patient Satisfaction with Refractive IOLs

The first problem is the limitations of current IOL technology. High and low-add multifocal, trifocal, and extended depth of focus (EDOF) diffractive optics all reduce spectacle wear compared to monofocal IOLs, but produce halos and unwanted images at night. Individual patient tolerance is unpredictable, and IOL exchange may be the only recourse for those that cannot adapt. Diffractive multifocal IOLs reduce contrast sensitivity, which can noticeably diminish optical quality and performance in the presence of ocular co-morbidities, such as maculopathy, optic neuropathy, keratopathy, or ocular surface disease. Multifocal IOLs are also much less forgiving of residual refractive error, and IOL tilt and decentration. For the surgeon, nothing is more demoralizing than when patients are dissatisfied with their visual quality or dysphotopsias despite careful preoperative counseling and perfectly performed IOL calculations and surgery.

The second problem is our inability to consistently achieve LASIK-like refractive accuracy. The 2018 ESCRS Eurequo study showed that 27% of eyes failed to land within +0.5 D of the target refraction. Despite improvements in biometry and IOL formulae, and the availability of intraoperative aberrometry, we must still correctly estimate the effective lens position (ELP), and surgically induced (SIA) and posterior corneal astigmatism (PCA). Prior LASIK and PRK introduce different errors into our IOL calculations. Although residual refractive error can be treated with keratorefractive surgery, many cataract surgeons do not perform these procedures. Patients may be disappointed with the additional procedure and expense that they did not expect, and with the several month delay until the refraction is stable.

A third major factor is the difficulty that so many patients have in understanding the refractive IOL value proposition. We require them to make an expensive purchase decision preoperatively, often without a way to fully comprehend or try out the outcome. We describe the benefits of different IOLs using confusing terminology such as astigmatism, presbyopia, depth-of-focus, and multifocality. In addition to these, patients struggle to understand other key optical concepts such as lenticular myopia, focal distance, anisometropia, halos, and contrast sensitivity. After describing the benefits, we then add disclaimers about still needing reading or distance glasses and not being able to guarantee a specific outcome.

Figure 1: Digital light delivery device

Adjustable IOLs

I believe that adjustable IOL technology will enable us to overcome most of these non-economic barriers. While there are several different technologies under development, the RxSight light-adjustable lens (LAL) has recently become commercially available in the United States. This 3-piece, foldable monofocal IOL is implanted through a 2.8 mm clear corneal incision with a proprietary injector. Approximately three weeks postoperatively, the patient is refracted and a slit lamp based digital Light Delivery Device (LDD) is used to adjust the IOL power by delivering UV light in a precisely programmed pattern (Figure 1). This causes spatially modulated polymerization of diffusible, photosensitive macromers within the 6 mm diameter silicone optic. The resulting diffusion gradient causes unpolymerized macromer to diffuse into irradiated zones with a resulting change in the shape and refractive power of the optic (Figure 2). Treatment times range between 50–90 seconds. One treatment can adjust up to two diopters of cylinder or sphere (in either direction). Additional staged treatments can bring the total adjustment up to 4.5 diopters of cylinder or sphere. After the newly adjusted refraction is confirmed several days later, a second 1-minute "lock-in" dose is given with the LDD to polymerize all remaining macromer, at which point no further refractive change can occur. Patients wear special UV blocking spectacles until the adjustment and lock in steps are completed.

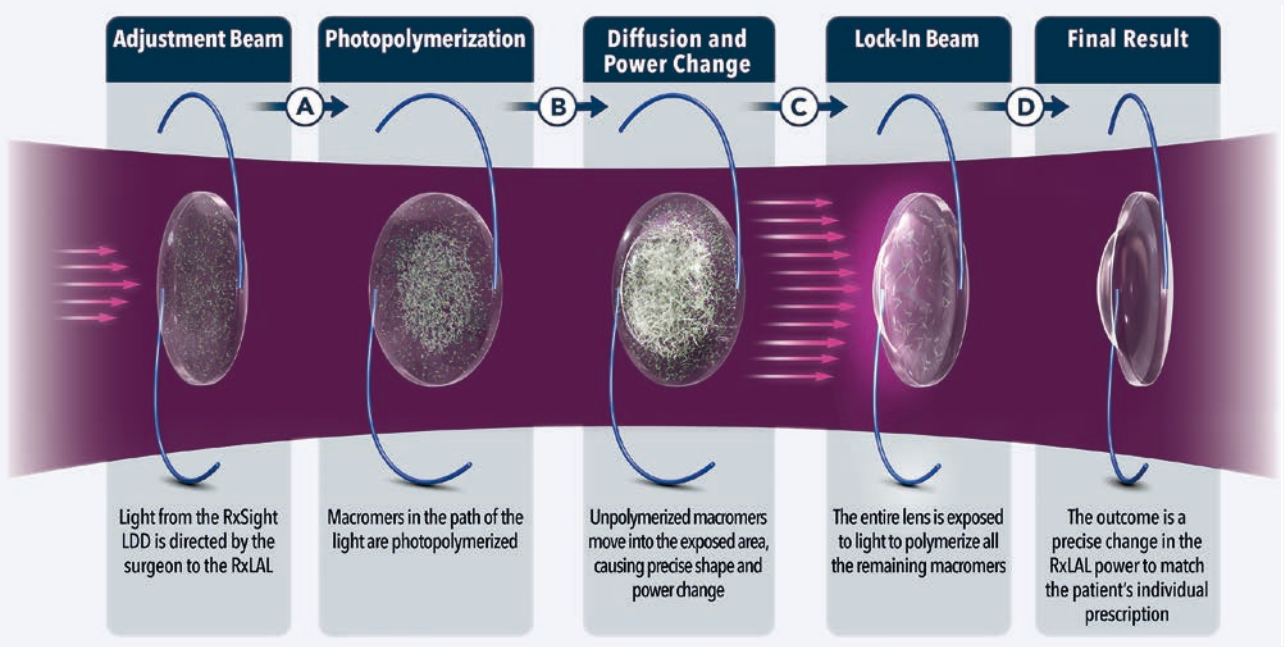


Figure 2: Schematic steps in the LAL power adjustment

Refractive accuracy – sphere and cylinder

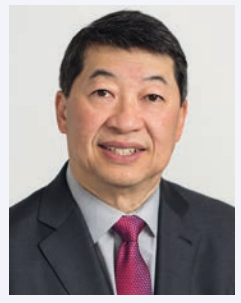
Advances in biometry and IOL formulae have improved refractive outcomes, but because the calculations must still estimate ELP, SIA, and PCA, they improve the average but don't eliminate the standard deviation. Accurate surgical toric IOL alignment is critical, but even after using intraoperative aberrometry and digital axis marking, the IOL can still rotate postoperatively. In contrast, the LAL allows us to treat the stabilized postoperative refraction after the IOL can no longer shift axially or rotate. The smaller incremental gains afforded by new IOL formulae and additional pre- and intraoperative diagnostic technology may be rendered superfluous by postoperative adjustability. Adjustable IOLs will be particularly helpful for challenging cases, such as post-LASIK or RK eyes, and outliers with unusual axial lengths, keratometry, or anterior chamber depth.

Improving the Patient Experience – "Choosing your Vision"

Perhaps the most overlooked benefit will be how much adjustable IOL technology will improve the patient's experience. The anxiety and stress of selecting their IOL and refractive goal preoperatively will be alleviated by allowing patients to choose and prioritize their refractive objectives postoperatively. Using a phoropter, loose trial lenses, or trial soft contact lenses, pseudophakic patient to preview different amounts of myopia in the near eye postoperatively, and then adjust in that optimal amount. As we know from contact lens monovision, some patients tolerate and prefer more anisometropia than others. Knowing that we can experiment with, and then modify or reverse different amounts of myopia in the distance and near eye should allow us to replicate the high levels of patient satisfaction seen with contact lens monovision. Finally, RxSight recently released an EDOF presbyopia treatment in Europe. The EDOF effect is produced by manipulating spherical aberration, rather than with a diffractive or small aperture optic.

Adjustable Mini-monovision

As a pseudophakic strategy to reduce spectacle dependence, mini-monovision using monofocal IOLs is consistently the most popular choice among ASCRS Clinical Survey respondents. Monofocal IOLs provide excellent optical quality while avoiding nighttime halos and starbursts. Adjustability should significantly improve outcomes with this strategy, starting with achieving emmetropia in the distant eye. Next, we can allow the bilaterally the patient can experience what correcting astigmatism does, without actually understanding the optics of it. They can test the effect of being slightly more or less myopic. Some patients desiring good distance vision may actually prefer -0.75 to plano. Others that prioritize reading without glasses may prefer being -1.75 to -2.75. These differences are difficult to describe and comprehend preoperatively, but are quite easy to demonstrate postoperatively.



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David F. Chang

Bilateral same-day sequential cataract surgery

There is growing interest in, and experience with bilateral, same-day, sequential cataract surgery. One advantage of staged sequential surgery is the ability to modify the IOL power selected for the second eye following a power surprise in the first eye. A second advantage is giving patients the opportunity to change the refractive target for their second eye based on their first eye outcome. These cease to be important considerations if we can adjust the spherical refraction postoperatively. Performing both cataract surgeries either simultaneously or within a few days of each other will make it easier for patients to test their pseudophakic refractive preferences, especially if some degree of anisometropia is intentionally sought. This will also make the LAL experience more convenient by shortening the period requiring UV glasses, and allowing both eyes to be refracted and adjusted simultaneously.

Adjustable IOLs will be a disruptive innovation

I believe that adjustable IOLs will be the new paradigm that will ultimately disrupt the field of refractive IOL surgery. In addition to providing better refractive accuracy, this technology will transform the patient experience – the process by which they choose their refractive objective, and how ophthalmologists will deliver it. Much of the preoperative refractive counseling can now be shifted postoperatively. After previewing and comparing different refractive targets, pseudophakic patients will better understand the options and be happier with their decisions and outcomes. ■

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Author: David F. Chang, MD
Clinical Professor at University of California
Los Altos, USA
e-mail: dceye@earthlink.net