LOS ALTOS, Calif.—To overcome the mul-
tiple obstacles of refractive IOLs, light adjustable IOL technology could be a valuable solution.

T he relatively flat growth in refractive IOL implantation worldwide is indicative of the continuing challenges that cataract surgeons face in meeting the refrac-
tive goals and expectations of their patients. These challenges make pre-
operative counseling time-consuming and stressful for both patients and their ophthalmologists. However, rushed or ineffective communication risks increasing postoperative dissat-
faction 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) optics all reduce spectacle wear com-
pared to monofocal IOLs, but produce halos and unwanted images at night. Individual patient tolerance is unpre-
dictable, 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 macu-
apathy, optic neuropathy, keratopa-
thy, or ocular surface disease. Multifo-
cal 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 counsel-
ing and perfectly performed IOL calculations and surgery.

The second problem is our inability to consistently achieve LASIK-like refractive accuracy. The 2018 ESCRS Eurosur study showed that 27% of eyes failed to land within ±0.5 D of the target refraction. Despite improve-
ments in biomeetry and IOL formulæ, and the availability of intraoperative abberometry, 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 calcula-
tions. Although residual refractive error can be treated with keratorefrac-
tive 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 sev-
eral month delay until the refraction is stable.

A third major factor is the difficul-
ty that so many patients have in understanding the refractive IOL value proposi-
tion. We require them to make an expensive purchase decision pre-
operatively, often without a way to fully comprehend or try out the out-
come. We describe the benefits of dif-
ferent IOLs using confusing terminol-
ogy such as astigmatism, presbyopia, depth-of-focus, and multifocality. In

Adjustable IOLs

I believe that adjustable IOL technol-
egy will enable us to overcome most of these non-economic barriers. While there are several different technolo-
gies under development, the RxSight light-adjustable lens (LAL) has recently-
become commercially available in the United States. This 3-piece, folda-
ble monofocal IOL is implanted through a 2.8 mm clear corneal inci-
sion with a proprietary injector. Approximately three weeks postop-
eratively, 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 pre-
cisely programmed pattern (Figure 1). This causes spatially modulated polymerization of diffractive, photo-
sensitive macromers within the 6 mm diameter silicone optic. The resulting diffusion gradient causes polymerized macromer to diffuse into irradiated zones with a resulting change in the shape and refractive power of the operative refraction after the IOL can no longer shift axially or torsionally. The smaller incremental gains afforded by new IOL formulæ and additional pre-
operative 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.

Adjustable Mini-monovision

As a pseudophakic strategy to reduce spectacle dependence, mini-monovi-
sion using monofocal IOLs is consist-
ently the most popular choice among ACSRS Clinical Survey respondents. Monofocal IOLs provide excellent optical quality, while avoiding night-
time halos and starbursts. Adjustabil-
ity should significantly improve out-
comes with this strategy, starting with achieving emmetropia in the distant eye. Next, we can allow the biaxially

Light adjustable IOLs

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

Figure 1: Digital light delivery device

Figure 2: Schematic steps in the LAL power adjustment

1. Adjustment Beam
2. Photopolymerization
3. Diffusion and Power Change
4. Lock-in Beam
5. Final Result

Light adjustable IOLs

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Bilateral same-day sequential cataract surgery

There is growing interest in, and expe-
tence with, bilateral, same-day, sequential cataract surgery. One advantage of staged sequential sur-
ery is the ability to modify the IOL power selected for the second eye fol-
lowing a power surprise in the first eye. A second advantage is giving patients the opportunity to change the refractive target for the second eye based on their first eye outcome. These ease to be important considerations if we can adjust the spherical refrac-
tion postoperatively. Performing both cataract surgeries either simultane-
ously 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 short-
ening the period requiring UV glasses, and allowing both eyes to be refracted and adjusted simultaneously.

Adjustable IOLs will be a dis-

Advances in biomeetry and IOL formulæ have improved refractive out-
comes, 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 intra-
operative abberometry and digital axis marking, the IOL can still rotate post-
operatively. In contrast, the LAL allows us to treat the stabilized post-
operative patient to preview different amounts of myopia in the near eye postoperatively, and then adjust in that optimal amount. As we know from empirical data, some patients tolerate and prefer more ani-
sometropia 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 manipu-
larizing spherical aberration, rather than with a diffractive or small aper-
ture optic.

Improving the Patient Experience — “Choosing your Vision”

Perhaps the most overlooked benefit will be how much adjustable IOL tech-
ology 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 prior-
itize their refractive objectives postop-
eratively. Using a phoropter, some trial lenses, or trial soft contact lenses, the patient can experience what cor-
recting astigmatism does, without actually understanding the optics of it. They can test the effect of being slightly more or less myopic. Some patients seeking good distance vision may actually prefer –0.75 to plano. Others that prefer reading without lenses may prefer being –2.75 to –2.5. These differences are difficult to describe and comprehend preopera-
tively, but are quite easy to demon-
strate postoperatively.