

THE FUTURE OF ADJUSTABILITY

Possible developments, logistical challenges, and the potential for enhanced patient outcomes during the next decade.

**ADAPTED FROM A SERIES OF INTERVIEWS BY
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DOUGLAS D. KOCH, MD; AND RICHARD L. LINDSTROM, MD**

Kendall E. Donaldson, MD, MS: Looking ahead at the next 5 to 10 years, what are the most exciting things you expect to happen with IOL technology and the potential for adjustability?

David F. Chang: Adoption of the Light Adjustable Lens (LAL; RxSight) and a new iteration, the LAL+ (RxSight), is accelerating in the United States. Everyone understands the benefit of eliminating residual refractive error postoperatively, particularly if the target is emmetropia. However, a major source of indecision and anxiety for many patients is not knowing what their full range of vision will be like after surgery with different IOL options and refractive targets. Some myopes badly regret the loss of near function that attaining emmetropia entails. A significant benefit of the LAL is the ability to trade some of the distance vision in one (or both) eyes postoperatively to regain better near to intermediate function based on the patient's daily experience. Toward this end, the LAL+ may provide up to a diopter of extended depth of focus in a slightly myopic eye. Patients can find the sweet spot where they have adequate intermediate/near for crucial activities, while sacrificing as little distance focus as possible.

Active Shield (RxSight) theoretically eliminates the need for constant UV protection postoperatively, and I no longer have my patients wear the clear UV glasses indoors. This has significantly improved the patient experience and lessened the urgency to get the LALs locked in as early as possible. Additionally, most of my patients elect to have immediate sequential bilateral cataract surgery with the LAL, which generally means they make the same total number of trips to the office as if they had done delayed sequential surgery with traditional IOLs.

With adjustable IOLs, we finally have an excellent IOL technology to reliably satisfy most refractive lens exchange (RLE) patients. I recently performed bilateral same-day RLE on my wife with the LAL+. Fortunately, I am still married! I believe that, as ophthalmologists gain more experience with the LAL, they will perform more RLE with this platform. The resulting word-of-mouth will increase patient interest and demand.



In terms of future advancement, efforts are underway to use femtosecond lasers or thermomechanical techniques to adjust pseudophakic refractions. Although these technologies are still in development, they hold the potential to allow adjustment of different IOL designs, such as a multifocal optic.

Douglas D. Koch, MD: Without a doubt, adjustability is a significant advance. I'm also particularly excited about optical strategies for IOLs that are not diffractive yet still provide an extended range of focus. These innovations could reduce positive dysphotopsia, which continues to be a substantial issue.

Despite our best efforts, the unpredictability of outcomes remains a concern. We can't always predict every result with absolute reliability, which is somewhat daunting. This inherent unpredictability has limited the widespread adoption of premium IOLs.

The advent of adjustable lenses and nondiffractive extended depth of focus IOLs, however, represents a promising step forward. These technologies could enhance patient satisfaction by offering customizable vision correction and reducing unwanted visual disturbances. Ultimately, this progress could lead more surgeons and patients to embrace premium IOL options.

I am optimistic about the potential of technologies like selective polymerization and refractive index shaping for multiple adjustments over a patient's lifetime, but these are still on the horizon. The financial and technical challenges they face are significant, and it will be some time before they become mainstream.

Another exciting development is the potential for improved biometers and more accurate formulas for IOL calculations. With better tools to predict effective lens

position and account for tilt with toric IOLs, we can improve our hit rates significantly. This is especially important for enhancing patient outcomes and confidence in premium lenses. I'm excited about advances in technologies for selecting the right IOL, enhancing patient education, and improving IOL calculations, especially for toric IOLs. Enhanced biometers and more accurate formulas could greatly help the average physician achieve their target more precisely on the first attempt, which would be a substantial improvement.

Richard L. Lindstrom, MD: Let's project 10 years into the future because advances often take longer than anticipated. A significant trend I foresee is the evolution of refractive cataract surgery into the primary form of refractive surgery.

We are seeing a shift toward operating on younger patients each year. Over the next decade, I anticipate an increase in the Medicare eligibility age. Consequently, patients will likely seek cataract or natural lens replacement surgeries before reaching Medicare age. These individuals, likely in their 60s, will aim to replace their *dysfunctional lenses*, a term I use to describe early cataract formation. Some will have commercial insurance, but many will opt to pay out of pocket.

When cataracts are defined as dysfunctional lenses, these issues typically manifest when patients are in their 50s, with most seeking replacement in their 60s due to dissatisfaction, much like myopic patients seek LASIK or laser-assisted lenticule extraction. This trend will lead patients to bear more of the costs, beneficially shifting the market toward a cash-pay model. Patients will demand high-tech products, superior experiences, and excellent outcomes.

In the realm of lens replacement surgery, I anticipate the introduction of adjustable and accommodating IOLs.

Adjustability and accommodation represent the most significant disruptive technologies. Adjustability enhances our precision in correcting both sphere and cylinder. The next groundbreaking development will be the accommodating IOL. In 10 years, we may very well see the widespread use of adjustable accommodating IOLs. Just as people replace their knees or hips when they become dysfunctional, they will replace their lenses with adjustable accommodating IOLs, heralding a new era in vision correction and quality-of-life improvements.

Currently, the LAL represents a significant advance. My initial investment in Calhoun Vision, the predecessor of RxSight, was 25 years ago. It has taken a long time to bring this technology to market. No surgeon can replicate the LAL's capabilities in terms of both sphere and cylinder accuracy and axis alignment.

Future adjustability might involve the use of femtosecond lasers to alter the refractive index of the natural lens. This has been challenging due to the minimal amount of adjustment achievable with each treatment and the necessity for precise eye movement control. Nevertheless, advances and potential breakthroughs from Nobel Prize-winning research could introduce new methods of adjustability.

Dr. Donaldson: We anticipate a rise in the number of cataract surgeries and the introduction of new technologies requiring additional clinic time and increased demands on physicians and staff. How can we manage and balance this growing demand for surgery with the increased workload from these new technologies?

Dr. Chang: Meeting the growing demand for cataract and RLE surgery will be a significant challenge, especially as our population ages. To address this, we will need to utilize integrated care more effectively,

with optometrists working alongside ophthalmologists and handling more of the refractive counseling and routine follow-up. This approach allows surgeons to focus on surgery. In our practice, our optometrists handle much of the postoperative decision-making with the LAL by simulating different outcomes with trial lenses.

Dr. Koch: With the LAL, we have an optometrist who handles much of the process. She brings in the LAL patients, performs the refractions, discusses their preferences, and conducts contact lens trials. I then do the light treatments, which makes the process efficient. This setup is more time-consuming than regular postoperative visits but still manageable.

We'll need to rely more on physician extenders like optometrists. We don't currently use physician assistants or nurse practitioners in my practice, but some practices do. An integrated approach is essential to handle the growing demand and ensure quality care.

I see a future when cataract surgery pathways diverge: a routine pathway for standard procedures and a premium channel with advanced, self-pay options for fine-tuning outcomes. This approach is vital as we face an increasing demand for cataract surgery with fewer ophthalmologists available.

Dr. Lindstrom: The integrated eye care delivery model is key. At Minnesota Eye, we utilize an ophthalmologist-led integrated model with ophthalmologists, optometrists, physician assistants, and technicians working side by side. In my opinion, it doesn't make sense for ophthalmologists to do their own refractions or light adjustments. In Minneapolis, we created a light adjustment center, Praxis Vision, where patients are referred for

adjustments after the initial implant. This model has allowed surgeons to focus on surgeries without additional time spent on adjustments.

This integrated approach is the most efficient scenario. As more states allow optometrists to perform light adjustments, however, this model will evolve. The growing demand and shrinking supply of ophthalmologists necessitate integrated care. Optometrists will need to take on more refractive counseling and postoperative care to allow surgeons to focus on surgeries. This shift will be essential to manage the workload efficiently.

Dr. Donaldson: Will IOL calculations still matter in the future with adjustable lenses?

Dr. Chang: Absolutely. We have many excellent nonadjustable, advanced technology IOLs, so hitting the refractive target remains crucial. A common question is, do we really need adjustable IOLs given how much better our formulas and biometry have become? I would answer that, when we miss the refractive target, the confounding variable is often the cornea. Even the best formulas can yield different results due to corneal variability, especially in patients with dry or abnormal ocular surfaces.

Dr. Koch: Adjustable IOLs are undoubtedly a significant advance, but I believe precise calculations will continue to play a crucial role in our practice. Although adjustability helps mitigate some of the unpredictability that has limited the adoption of premium lenses, we still face challenges in ensuring optimal outcomes for all patients, particularly those who may not be able to afford these advanced technologies.

Even with the perfect biometer, nailing the target the first time remains essential. The cost and time associated with adjustments are

substantial. Not every patient can afford adjustable lenses, which means we need to maintain excellence in our traditional IOL calculations and surgical techniques to ensure good outcomes for all patients, regardless of their economic status.

Dr. Lindstrom: Accurate preoperative measurements will always be crucial. The cornea's variability affects outcomes, so we need to get as close as possible to the desired result before making any adjustments. The happiest outcome is not having to do an adjustment at all. Advanced calculations and measurements will remain vital in achieving this goal.

Dr. Donaldson: Are we creating any new potential complications with adjustability?

Dr. Chang: Patient education is different in terms of delineating expectations because we plan to change the IOL postoperatively. Although some patients achieve spectacle freedom, others do not, and this must be understood. We often select this IOL for patients with irregular or variable corneas—post-LASIK, post-radial keratotomy (post-RK), post-penetrating keratoplasty, keratoconus, etc. It is easy for these patients to inadvertently be misled, or to mislead themselves, into thinking that the LAL will correct their irregular corneal aberrations, which may be contributing to poor image quality. Variable acuity due to dry eye or epithelial basement membrane dystrophy is also not mitigated by any IOL—adjustable or not. If these issues are not understood in advance, patients may be especially unhappy because of the additional expense and multiple postoperative visits that they have invested in their outcome.

Before Active Shield, we had LAL patients who developed optical

distortion postoperatively, which we believed was due to UV light-induced aberrations in the IOL. These patients had initially clear vision that then became subjectively blurry. Wavefront aberrometry (iTrace, Tracey Technologies) sometimes identified these aberrations as being lenticular. An IOL exchange with a new LAL restored clear vision, indicating inadvertent UV polymerization despite a history of good UV spectacle compliance. We have not seen this happen since the incorporation of the Active Shield into the LAL.

Adjusting the LAL before the cornea and refraction have stabilized is another potential problem. Misleading refractions due to evaporative dry eye, medicamentosa, or other punctate keratopathy are also concerns. We've learned to wait longer to adjust eyes that are post-RK or have highly aberrated post-LASIK corneas and to intensify ocular surface treatment postoperatively in these challenging eyes.

Adequate pupillary dilation is a prerequisite to using this technology. A progressive reduction in mydriasis diameter occurs in some patients postoperatively, which can require multiple sets of dilating drops and prolonged clinic wait times. Be cautious if the pupil barely dilates to 6.0 mm preoperatively. Finally, surgeons must be sure to take time to double check the data entered into the treatment screen of the light delivery device before initiating an adjustment. Mistaken data entry, transposing plus or minus cylinder, or even accidentally locking in the IOL rather than adjusting it could all happen due to human error.

Dr. Koch: Adjustability in IOLs certainly offers a lot of benefits, but like any new technology, it comes with its own set of potential complications. One of the primary concerns is the material used in

these lenses. For example, silicone, although generally well tolerated, can sometimes be a source of issues such as calcification in the presence of asteroid hyalosis with an open posterior capsule.

Another concern is the potential for inducing new aberrations during the adjustment process in eyes with highly aberrated corneas. These could occur if posterior corneal aberrations interact unpredictably with the adjustments made to the IOL.

Finally, there is the concern about long-term stability following lock-in. This is a big concern in post-RK eyes that have unstable corneas and, in particular, can be prone to ongoing flattening.

Dr. Lindstrom: With adjustability, particularly with technologies like the LAL, there are a few potential complications to consider. One issue is fixation. If the patient's eye moves during the light adjustment process, it can lead to a decentered treatment, which can induce higher-order aberrations like coma. This is similar to what can happen with a decentered excimer laser ablation or laser-assisted lenticule extraction procedure.

Another potential complication is light exposure. Patients need to protect their eyes from UV light postoperatively to prevent unwanted polymerization before the lens is locked in. If patients do not wear their UV-protective glasses, especially in bright environments, there's a risk that the adjustability might be compromised or they might end up with an unintended refractive outcome.

Additionally, there's always the possibility that patients will not follow through with their adjustment appointments. If a patient decides not to return for their scheduled adjustments, the ambient light might partially lock

in the lens, potentially leading to suboptimal results.

We've also seen that removing the LAL can be more challenging than removing traditional lenses. Specific techniques and tools are required, which can be a bit more demanding for the surgeon. ■

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