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Seeing Clearly: A Bright Future with Light Adjustable Intraocular Lenses for Presbyopia

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Seeing Clearly: A Bright Future with Light Adjustable Intraocular Lenses for Presbyopia

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Presbyopia, or the age-related decline in the ability to focus on near objects, is a common vision disorder that affects 1.8 billion people globally, with this number expected to increase to 2.1 billion by 2030.[1–4] A diminished accommodation response is the primary cause of presbyopia.[1] The eye has a very complex accommodation mechanism that permits people to distinctly see objects from various distances.[1,3] Even though the precise mechanism of accommodation is yet to be determined, the current evidence strongly supports Helmholtz's theory, which claims that the thickness and curvature of the eye's lens increase while its diameter decreases following the contraction of ciliary muscles, which subsequently leads to an increase in lenticular power, and hence, the eye's accommodation.[1,2] Although it has been proposed that weakening of the ciliary muscles may contribute to presbyopia, the decrease in the elasticity of the lens has been widely accepted to be the chief cause of presbyopia.[3] Currently, about 85% of individuals 40 years and older have presbyopia, with an estimated 128 million people living with presbyopia in the United States alone.[3,4] Given the prevalence of this age-related condition in an aging population, advancements in treatment for presbyopia have the potential to affect many lives.

There is a wide range of treatments for presbyopia. The most common treatment for presbyopia, and one which is readily available at many non-specialty retailers is the utilization of noninvasive corrective lenses. While this is a cheap and easily accessible form of treatment, it is not one-size-fits-all. One cohort study found that older individuals wearing multifocal glasses were twice as likely to fall compared to individuals not wearing multifocal glasses.[3] A randomized control trial concluded that substituting multifocal glasses with single vision glasses in the elderly population reduced the number of falls by 8%.[3] Pharmacological therapies like lipoic acid and choline ester chloride, pupillary miotics, as well as muscarinic agonists are being incorporated into the treatment regimens for presbyopia and provide more options for individuals.[1–4] However, many of these therapies are not optimal and demand some type of compromise in one's vision.[3] This cost-benefit must also be considered in the treatment of presbyopia with more invasive surgical interventions including the implantation or exchange of intraocular

lenses, corneal inlays, and procedures which use lasers to reshape the cornea.[1,3,4] Traditional surgical management of presbyopia puts immense stress on the patient. Unlike glasses, which the patient can easily adjust after trying them on, the patient is unable to test out what his or her vision will be like following the surgical intervention. This leaves patients and ophthalmologists with difficult preoperative discussions as the patient has to communicate his or her vision goals to the ophthalmologist, who would then execute complex calculations to obtain the proper prescription.[5] Such issues can be resolved with the light adjustable intraocular lens (LAL), which is the only surgical tool that permits patients to test out the prescription to ensure that it is functioning properly and meets their needs.[5]

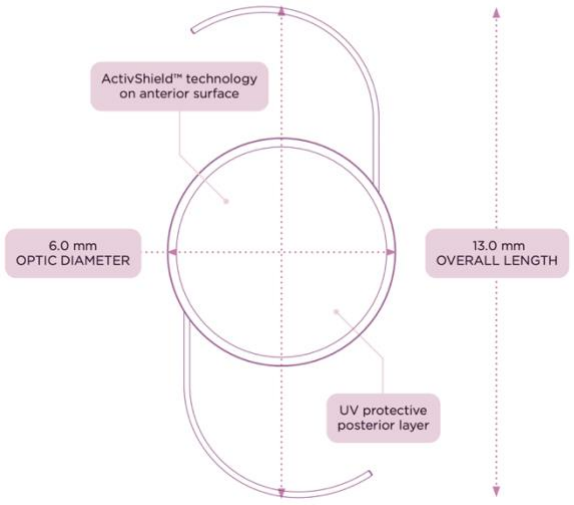

Figure 1: A light adjustable is pictured, with demonstration of its small size and UV protective abilities. Taken from RxSight®

The light adjustable intraocular lens is a recent revolutionary technological breakthrough in ophthalmology. Currently provided through RxSight®, LALs have been extensively studied in cataract surgery and are an ideal treatment for presbyopia.[6–10] Although LALs were developed in the late 1990s by Drs. Daniel Schwartz and Robert Grubbs, they were first approved by the Food and Drug Administration for use in cataract surgery in 2017.[6] The fundamental technology of LAL relies on two primary principles—photochemistry and diffusion—that establish different polymer gradients that are capable of altering both the shape and power of the lens.[5,6] The primary benefit of such technology is that the lens customization occurs postoperatively and after healing has occurred. This assures both patients and ophthalmologists that any unpredicted refractive changes from the natural healing process can be fine-tuned after surgery.[5–7,10] Prior to the LAL, treatment options to residual refractive error included glasses, corneal refractive surgery like LASIK or PRK, limbal relaxing incisions, piggyback lenses, or lens exchange. LAL is an excellent option in patients who have had prior refractive surgery where intraocular lens power calculations can be less accurate and in patients who are otherwise not multifocal candidates.

To treat presbyopia, a technique called blended vision is used where the dominant eye is targeted for distance vision, while the non-dominant eye is

targeted to the desired amount of nearsightedness. Targeting the nondominant eye for just the right amount of nearsightedness allows the patient to be functional at near vision, without sacrificing much of their distance vision in that eye. Although monovision is not a novelty, this is the first time where adjustments can be made post-surgical placement of the lens, allowing patients to customize their visual needs post-operatively.

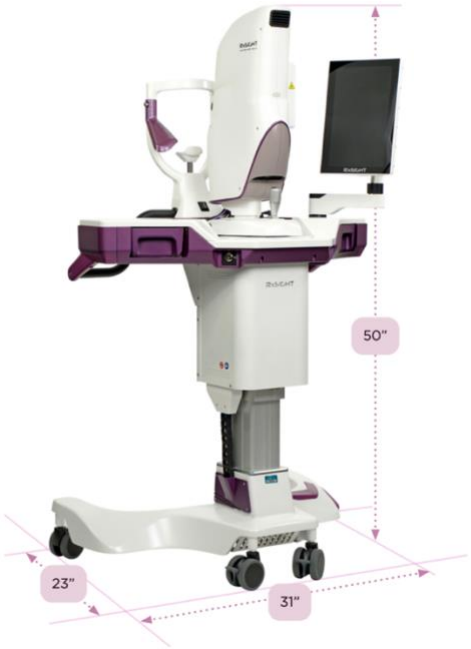

Figure 2: This light delivery device provides targeted UV radiation which adjusts the shape and power of the LAL. Taken from RxSight®

An RxSight LAL is a compact three piece posterior chamber biconvex lens (Figure 1).[5,6,11] The LAL's optic area is made up of photoreactive silicon macromers that polymerize upon the delivery of ultraviolet (UV) light at 365 nm, modifying the lens's shape, and consequently its refractive power.[6–10] Ophthalmologists are able to adjust the refractive power of the lens following the surgical procedure via the utilization of a light delivery device that sends out UV radiation until the desired refractive outcomes are achieved (Figure 2).[5–11]

Following the implantation of LAL, patients are advised to wear UV protective glasses to prevent the lens from altering its shape, and then undergo a series of up to 3 non-invasive adjustment sessions, where UV light is directed at the lens to modify its structure and corresponding refractive power, until the desired refractive outcome is met (Figure 3).[6–10,12] Subsequently, two additional "lock-in" treatments with UV light are carried out to maintain the desired refractive power.[5,6]

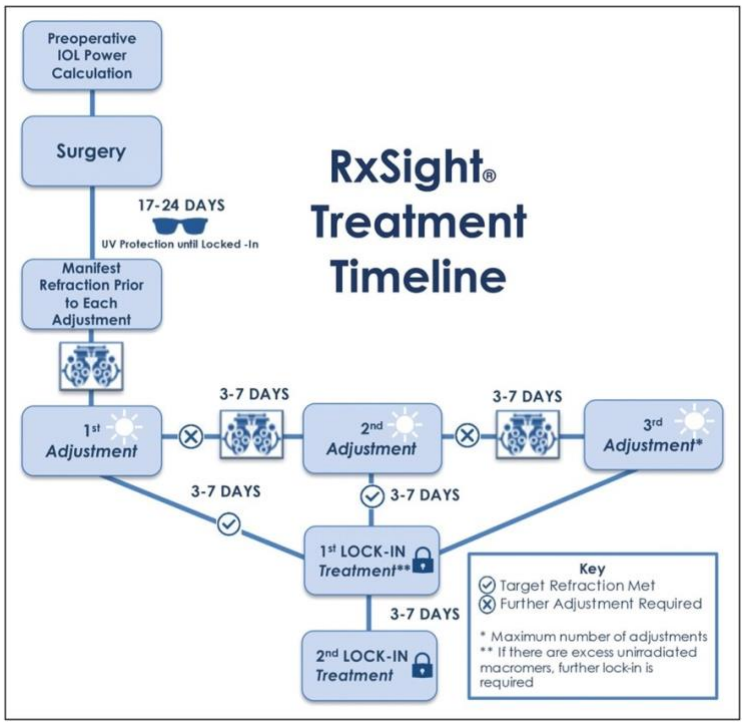

Figure 3a

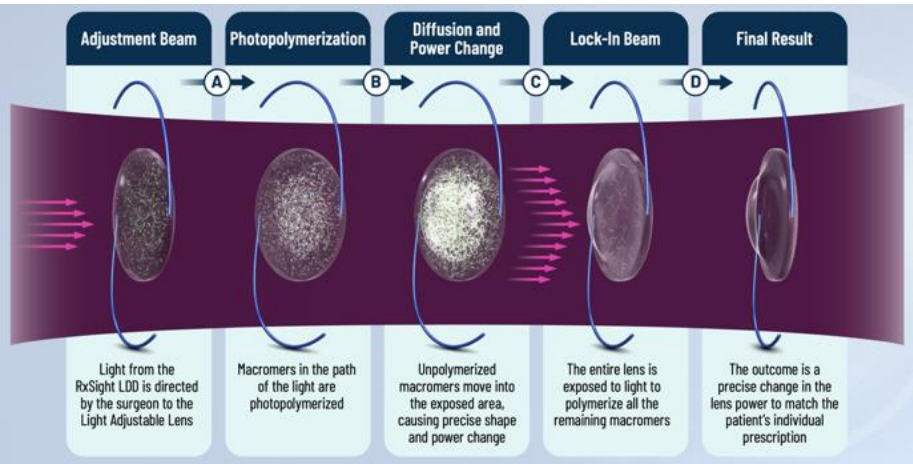

Figure 3a &b : The chronological steps of LAL adjustment and a treatment schematic are demonstrated. Taken from RxSight®

Indeed, several studies have demonstrated the efficacy of LAL, with some even equating it with "LASIK-like outcomes."[7,10] Reports highlight the effectiveness of LAL in correcting astigmatism and stress that patients who obtained a LAL are two times more likely to have a 20/20 vision without any glasses.[7,10] However, one potential drawback of LAL is that a failure to wear the UV protective glasses can lead to unintentional modification of the lenses' shape and refractive power, which can deter many individuals from seeking LAL.[6–9] This challenge was addressed recently in 2021 when RxSight released a second generation of LAL that are equipped with ActivShield® technology, which offers a strong UV protective layer, and thus reduce the need to consistently wear UV protective glasses.[7,10] In the same way, reports have asserted that there are no substantial adverse effects from the multiple exposure to UV light in the adjustment sessions and affirmed the high safety profile of LAL.[6–8,10] Still some concerns regarding the complications that can result from silicone, which is inherent to all intraocular lenses, as well the increased costs due to successive UV treatment sessions can discourage some patients from seeking LAL.[6,7] One drawback at the provider level is the high cost of the light delivery system, with some ophthalmologists dreading the expensive initial investment.[10] Meanwhile, several ophthalmologists mentioned that offering LAL to patients has expanded their practices and have even had a return on their investment in only three to nine months.[10]

Truly, the LAL provides a unique alternative to the traditional presbyopia treatment methods, including the multifocal and extended depth of focus (EDOF) lenses, which are targeted for presbyopia but are unable to be adjusted after surgery. Its revolutionary technology empowers both the ophthalmologist and the patient. Gone is the time when ophthalmologists and patients are limited to invasive treatments to fix any residual refractive error. The only thing that is needed is for the patient to follow-up after surgery and communicate his or her vision goal with the ophthalmologist, who will

non-invasively apply UV light to attain the intended lens power.

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