The Science Behind the AcrySof IQ IOL

Details from one of the minds behind this aspheric IOL design.

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The **AcrySof IQ** IOL (Alcon) is designed to provide a youthful lens to patients with cataracts. With its advanced biocompatible material and innovative design, it is designed to mimic the young adult lens by not only reducing spherical aberrations, but also filtering blue light. The design of the **AcrySof IQ** IOL reduced total higher-order aberrations (HOAs) and improved mesopic contrast sensitivity at 6 cpd (with and without glare) and functional vision versus the prior spherical control.[1]

GOLDEN OPPORTUNITY

Studies have shown that HOAs may provide some benefits, such as a natural defense against ocular chromatic aberrations[2] and mitigation of image deterioration by myopic defocus.[3] However, HOAs also degrade optical image quality.[4,5] Due to its high refractive power, the cornea is a known primary contributor to HOAs.[5,6] For instance, at a typical 6-mm pupillary diameter, the cornea contributes about +0.274 µm of spherical aberration,[7] a larger portion than that of any other contributor.

In the young lens, the cornea contributes positive spherical aberration, while the crystalline lens contributes negative spherical aberration. This results in the overall spherical aberration of the eye being slightly positive. With age, physiologic changes occur in the crystalline lens, which cause the overall spherical aberration of the eye to become more positive.

When surgeons remove a cataract and implant an IOL, a golden opportunity presents itself: to use an IOL that, in my opinion, provides just the right amount of negative spherical aberration, an amount that is similar to that of a young adult's natural crystalline lens.[7,8-10]

After developing the AcrySof IQ IOL, our analysis showed that the majority of patients had a spherical aberration typical of a young adult lens.[1]

OPTIMAL SPHERICAL ABERRATION

In designing the **AcrySof IQ** IOL, we looked at multiple studies that revealed the typical young adult human lens has an internal lens spherical aberration of -0.18 µm.[6,7,9,11] Thus, we designed the **AcrySof IQ** IOL with a spherical aberration of -0.2 µm to give patients a modest residual positive spherical aberration (ie, ~ +0.1 µm at a 6-mm entrance pupil) (Table). This amount is consistent with that found in a young adult lens at peak visual performance,[12] in US Navy pilots,[13] and in a visual performance study that included young subjects.[14]

Table. Residual Aberration Profiles*

	AcrySof® IQ	Tecnis‡ 1	SofPort AO‡	Akreos‡	Softec HD‡	enVista‡
Aberration correction of the lens§	-0.20 µm[8,9]	-0.27 µm[8,9]	0 µm[8]	0 µm[9]	0 µm[10]	0 µm[11]
Residual aberration of the eye§	0.07 µm	0 µm	0.27 µm	0.27 µm	0.27 µm	0.27 µm

*As reported from sources listed below in this graph. Data as of 2012.
‡Trademarks are the property of their respective owners.
§Residual aberration of the eye equals average corneal spherical aberration (0.27 µm) minus aberration correction of the lens.
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Providing just the right amount of spherical aberration produces excellent patient outcomes. After developing the **AcrySof IQ** IOL, our analysis showed that the majority of patients had the spherical aberration typical of a young adult lens.[1]

MATERIAL AND DESIGN

The single-piece **AcrySof IQ** IOL is composed of a high refractive index, soft, foldable, hydrophobic acrylic material. The **AcrySof IQ** IOL is available in two separate options: an ultraviolet-blocking lens and an ultraviolet and short wavelength blue light-filtering lens. Blue-light filtering chromophores were added to the **AcrySof** design to mimic filters in a young adult's crystalline lens. These chromophores have been shown to contribute to increase glare tolerance and functional vision versus IOLs lacking this specific chromophore.[15]

Design features of the **AcrySof IQ** IOL address surgical challenges such as achieving refractive predictability while minimizing HOAs.[1] With moderate surface asphericity, the **AcrySof IQ** IOL helps compensate for optical degradation caused by surgical misalignments such as lens decentration and tilt.

Because of its central lens thickness of only about 0.6 mm for mid-power lenses, the **AcrySof IQ** IOL can be delivered via small incisions,

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Calculating Optimal Spherical Aberration

Because spherical aberrations originate in both the cornea and the lens, surgeons should choose the right IOL for each patient based on the total aberrations of the cornea and the IOL. Here are a few things to remember:

- Patients with a modest positive spherical aberration (+0.1 µm) experience better vision than those with none. Young adult eyes have a small amount of positive spherical aberration, which is a result of the combination of positive sphere in the cornea and negative sphere in the lens. But as the crystalline lens ages, its spherical aberration increases.
- All eyes are different, with different levels of corneal spherical aberration. Eyes can be matched to different aspheric IOLs for optimal results. The goal is to approximate youthful vision with similar residual spherical aberration.
- The asphericity of the **AcrySof IQ** IOL is -2.0 µm, a number designed to net eyes with the median spherical aberration of about +0.1 µm (the optimal positive value). A modest amount of positive spherical aberration also acts as a natural defense against ocular chromatic aberrations[2] and mitigates image deterioration by myopic defocus.[3] The goal is to offer the benefits of reduced spherical aberration to the greatest number of people, while maintaining the IOL's insensitivity to tilt or decentration.

without altering the magnitude of corneal HOAs.[16] This capability is also aided by the lens material, which is appreciated for its foldability. In addition, the low rate of Nd:YAG of all **AcrySof** IOLs has been attributed to the **AcrySof** material and square-edge design.[17,18]

Clinical studies assessing tilt and decentration have confirmed the stability of the single-piece platform[19,20] as well as the benefits of the STABLEFORCE haptic modified-L design used in the supporting haptics of the **AcrySof IQ** IOL.[1]

CLINICAL RESULTS

Physicians worldwide rely on the proven material, innovative design, and optimal asphericity of the **AcrySof IQ** IOL. It provides patients with crisp and reliable vision. Since the introduction of the **AcrySof IQ** IOL, over 100 million of these lenses have been implanted worldwide.

Compared to spherical IOLs, the **AcrySof IQ** IOL has shown a significantly superior reduction of spherical and total HOAs as well as significantly superior results with mesopic contrast sensitivity at 6 cpd with and without glare.[1] In the same study, night-driving simulation testing and FACT contrast sensitivity testing showed that those implanted with the **AcrySof IQ** IOL had better functional vision in some of the most challenging driving conditions, such as in fog and under the glare of city lights.[1]

Furthermore, the **AcrySof IQ** IOL excels. Research has shown that patients had excellent vision when surgeons targeted a residual spherical aberration of +0.1 µm rather than 0 µm following cataract surgery.[1] Eyes targeted for +0.1 µm spherical aberration had improved contrast sensitivity (versus control) at 3 cpd and 6 cpd in both photopic and mesopic conditions.[1]

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