INSERT TO
CRST
Cataract & Refractive Surgery Today

Sponsored by
Alcon

LIGHT ENERGY MANAGEMENT IN DIFFRACTIVE PRESBYOPIA-CORRECTING IOLS

BY BRET FISHER, MD; XIN HONG, PHD, FAAO; ANDREA PETZNICK, PHD



The goal of presbyopia-correcting IOL (PCIOL) technology is to provide good vision at various distances and to keep the light utilization high to preserve visual performance. How is that achieved, and what are different approaches?

Both multifocal and trifocal IOLs use diffractive optics to create more than one simultaneous image on the retina to allow the patient to see at multiple distances. The diffractive element can be located on the anterior or posterior surface of the IOL and cover a part of or the total optical area.

As multifocal and trifocal IOLs have a different number of focal points, a different approach may be used to achieve the best light utilization for each IOL type. Depending on the design intent, there are two general strategies that optimize light energy distribution of a multifocal or trifocal IOL:

1. Apodization (gradual diffractive step height change): this achieves a gradual change in light energy distribution within the diffractive zone.
2. Ratio of diffractive zone versus optic diameter: the light energy distribution remains at the same level within the diffractive zone for each focal point, but changes as soon as the pupil size is larger than the diffractive zone.

Additionally, a combination of the two general strategies may also be used.

ACRYSOF IQ RESTOR +3.0 D AND ACRYSOF IQ RESTOR +2.5 D WITH ACTIVEFOCUS OPTICAL DESIGN

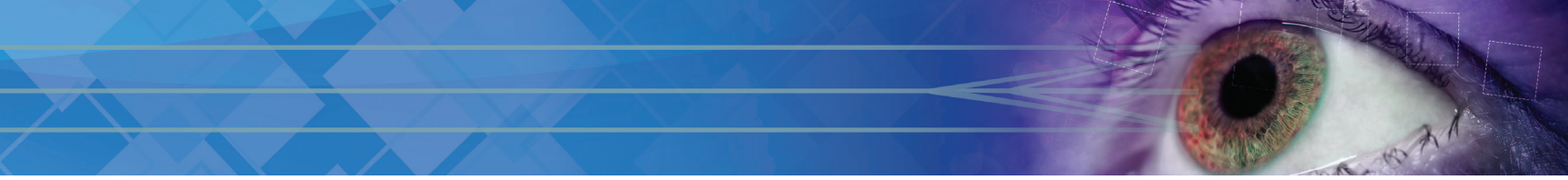
The AcrySof IQ ReSTOR +3.0 D IOL and AcrySof IQ ReSTOR +2.5 D IOL with ACTIVEFOCUS optical design are aspheric, diffractive multifocal IOLs characterized by a central diffractive zone and an outer refractive zone. The diffractive zone for AcrySof IQ ReSTOR +3.0 D IOL and AcrySof IQ ReSTOR +2.5 D IOL with ACTIVEFOCUS optical design covers the central 3.6 mm (9 rings) and 3.4 mm (7 rings) diameter area, respectively.[1] The diffractive structure diverts light simultaneously into 2 distinct focal points: 1) distance and 2) intermediate or near (depending on the add power). The outer refractive zone exclusively directs light to the distance.

The design intent for AcrySof IQ ReSTOR +3.0 D IOL and AcrySof IQ ReSTOR +2.5 D IOL with ACTIVEFOCUS optical design is to provide good distance vision with any pupil size, especially in low light conditions. Therefore, the light energy distribution for the AcrySof IQ ReSTOR +3.0 D IOL and AcrySof IQ ReSTOR +2.5 D IOL with ACTIVEFOCUS optical design are optimized using both of the two light energy management strategies, apodization, and a smaller diffractive zone. This combination allows for a gradual change in light energy distribution.

Firstly, apodization ensures good distance performance with any pupil size as it reduces optical phenomena in low light conditions.[2,3] Characteristic of the apodized diffractive design is the step height that reduces from the center toward the periphery of the optic. As the step height reduces and the pupil dilates, the light energy is progressively redirected from the near focus to the distance focus.[4] A smaller diffractive zone ensures that, for pupil sizes larger than the diffractive zone, additional light is being directed to distance to provide good distance vision in low light conditions.

PANOPTIX TRIFOCAL

The PanOptix Trifocal IOL is also an aspheric, diffractive IOL with a central diffractive zone and an outer refractive zone. The diffractive zone covers 4.5 mm (15 rings) of the central optic zone and diverts light simultaneously into 3 distinct focal points: distance, intermediate, and near. The outer refractive zone from 4.5 mm to 6.0 mm directs light to distance.



Different to the ReSTOR multifocal IOLs, the design intent for PanOptix Trifocal IOL was to provide a full range of vision, especially intermediate and near, in various lighting conditions while maintaining good distance vision. A clinical study showed that the PanOptix Trifocal IOL provides the possibility of distance, intermediate, and near vision with a visual acuity of 20/20*† or better using a binocular defocus curve, which allows for a reduced need for spectacles.[5]

The light energy distribution for the PanOptix Trifocal IOL is therefore managed by the diffractive structure diameter. Such an approach provides consistent light energy at each of the focal points within the diffractive zone. The diffractive zone for the PanOptix Trifocal IOL was balanced at a 4.5-mm diameter to enable near and intermediate vision, as well as distance performance in low light conditions. For pupil sizes beyond the 4.5-mm diffractive zone, additional light is being directed to distance as needed for night driving.

SUMMARY

There are different strategies used to manage light distribution in today's PCIOLs, and the design intent is an important deciding factor in the selection of the appropriate light management strategy. ■

1. Alcon Data on File.
2. Vega F, Alba-Bueno F, Millan MS. Energy distribution between distance and near images in apodized diffractive multifocal intraocular lenses. *IOVS*. 2011;52(8):5695-5701.
3. Lee CS, Simpson MJ. Diffractive Multifocal Ophthalmic Lens. United States Patent Number: 5699142. December 16, 1997.
4. Cohen AL. Diffractive bifocal lens designs. *Optom Vis Sci*. 1993;70(6):461-468.
5. AcrySof® IQ PanOptix® Trifocal IOL Directions for Use.

BRET FISHER, MD
■ Medical Director of The Laser and Surgery Center, The Eye Center of North Florida, Panama City, FL

XIN HONG, PHD, FAAO
■ Distinguished Fellow, Surgical R&D, Alcon Inc.

ANDREA PETZNICK, PHD
■ Associate Medical Director, North America Medical Affairs, Alcon Inc.

*Based on mean value of binocular defocus curve at near, intermediate, and distance at 6 months (n = 127).
†Snellen VA was converted from logMAR VA. A Snellen notation of 20/20-2 or better indicates a logMAR VA of 0.04 or better, which means 3 or more of the 5 ETDRS chart letters in the line were identified correctly.