The Story Of Restoring Vision With ReSTOR IOL

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In this fast moving world everybody wants to live without the weight of the glasses on the bridge of their noses. To achieve this after a cataract extraction, we need to provide at least two images with the help of a single IOL. Technology for spectacle glasses has evolved to do this while the same is not true for IOL. The industry is trying this in the form of Multifocal IOLs since a long time and with partial success. Let's tread the path of past and the present.

In an Endeavour to give multifocality, IOLs were made using either the Refractive or the diffractive principle. They could not solve the problem of Haloes, glare, rivalry of images and were not independent of pupil size. In short they worked only for some tasks and not for all the conditions they were intended to. Also they added a few undesirable effects and thus were never looked upon as a complete solution.

At present a new Hybrid IOL with some added innovative technology has arrived-The ReSTOR **(pseudoaccomodative diffractive, apodized IOL).**

REFRACTIVE TECHNOLOGY

Refractive optics bend light rays to a fixed focal point as they pass through a smooth and continuous lens. Standard monofocal lenses are a primary example of refractive optics.

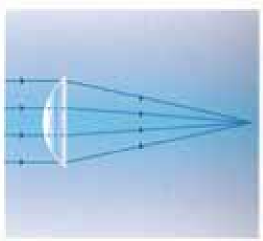

Figure 1 Refractive Technology

DIFFRACTIVE TECHNOLOGY

Diffractive optics divide incoming light into multiple wavefronts using small steps on the optic surface which can be designed to produce two sharp focal points by wavefront interference.

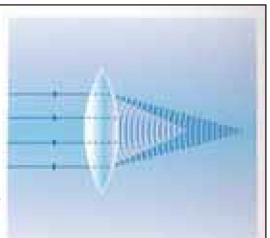

Figure 2 Diffractive Technology

Let's study these terms.

THE REFRACTIVE LENSES

PRINCIPLE:

The optical zones of a zonal refractive lens direct light to either the distance or the near focus and each zone acts as an independent lens.

RESULTS:

But it is the edges of this zone which diffract the light whenever encountered. The light spreads out and leads to a reduction in image quality if the diffractive effects are not controlled. Even if a significant portion of the light goes to the focus, image contrast is reduced. This property of zonal refractive lenses is further compounded by the pupil of the eye, whose diameter varies with illumination level and object distance. Lens cent ration also becomes utmost important. Hence image quality provided by a zonal refractive lens can be very variable, particularly for near vision situations.

THE DIFFRACTIVE LENSES (FULL OPTIC):

PRINCIPLE:

They divide incoming light into multiple wave fronts using small steps on the optic surface which can be designed to produce 2 sharp focal points by wave front interference. They also have different areas for different focus but unlike the refractive lenses this are much smaller steps and thus they all work cohesively to create two lens powers and thus two images. Here also the edge steps diffract the light, but this effect is controlled by placing the steps wherever the optical path distance increases by one wavelength. These boundaries are thus put in a definite pattern. By specifically designing the placement of these zones and introducing a controlled phase delay between zones, a full optic diffractive lens can produce two distinct images.

RESULTS:

This kind of optic provides the same energy proportion to the two images for all pupil diameters. This leads to excessive light energy being allocated to the near image under low lighting conditions where the pupil is large, which results into HALOS-the biggest bug bear of any multifocal lens.

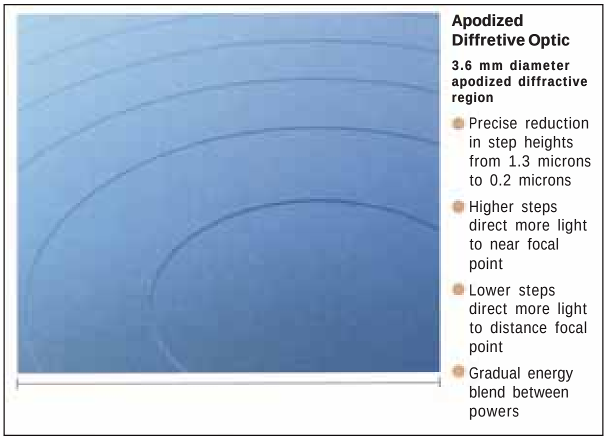

Figure 3

ReSTOR has everything in it namely Refractive area and Diffractive Apodized

Apodization is a gradual reduction or blending of the diffractive step heights. In ReSTOR it is found within central 3.6 mm optic zone. This mechanism creates a smooth transition of light between distance, intermediated and near focal points. Has a definite system in which the step height reduction is from 1.3 microns to as low as 0.2 microns. Let me remind you that the thickness of the human hair is 60 mic and the diameter of a RBC is 7 microns.

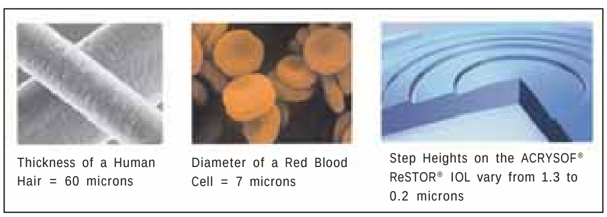

Figure 4

As explained previously The ReSTOR has a central 3.6mm diffractive region (unlike the full optic diffractive IOL) and they are of decreasing height from centre to periphery (apodization). The location of the steps determines the "add" power and the height of each diffractive step controls the proportion of the light that is directed to the two primary lens powers. In This apodization higher steps direct more light to near focal point and the lower steps direct more light to distance focal point. Gradual energy blend between powers leads to smaller and smaller defocus points. In short as light passes through the apodized diffractive portion of the lens optic, these steps on the anterior optic surface create light waves that form distinct images, as the waves intersect at diff focal points. These multiple points of focus, therefore, enable the patient to achieve a quality range of vision, near through distance.

Essentially, apodization gradually changes the proportion of energy directed to the two primary images as the pupil diameter changes. The apodization greatly increases the proportion of energy directed to the distance focus for larger pupil diameters.

People need good vision at all distances, but rarely need to read or do close work in dim illumination., when their pupils are larger. Additional light can usually be provided for objects near at hand. The energy directed to the near image remains constant as the pupil expands outside the diffractive region, and patients can typically still read a menu in a restaurant. Bright point light sources, however can sometimes cause visual phenomena at night, such as when viewing a distant street lamp. This is because the defocused image from the second lens power may sometimes be visible as a halo, because it is on a dark background. To minimize this possibility, the diffractive structure only covers the central region of the Acrysof ReSTOR lens, where the energy is fairly evenly divided b/w distance vision and near vision.

For larger pupils, more energy is directed to the distant focus, as the outer region of the lens solely provides distance vision (refractive Portion).

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ANOTHER FEATURE OF THIS LENS IS +4.0D ADD POWER:

THIS translates into +3.2 D at the spectacle plane. It also separates the near and distant images. But one important effect of this is that one should remember that the best reading distance here is of 31-32 cm. Cataract patients over the age of 60 have become accustomed to absolute presbyopia and a fixed reading distance of about 36cms(with a typical 2.5 or 2.75 D spectacle add). Developing presbyopes on the other end have gradually increased their reading distance to compensate for their gradual loss of accommodative amplitude and may have become used to a reading distance of arms length or even greater .These patients therefore, need to understand that their best reading distance following bilateral implantation may be a bit closer than what they have been accustomed to. It usually settles to 34-35cms that is in between 31 and 36.

THE OPTICAL SYSTEM

This explains how A D optic tech works. In ReSTOR's optical system the engineers have delivered a light distribution at different pupil sizes which much more closely reflects the physiological requirements than a zonal refractive IOL does.

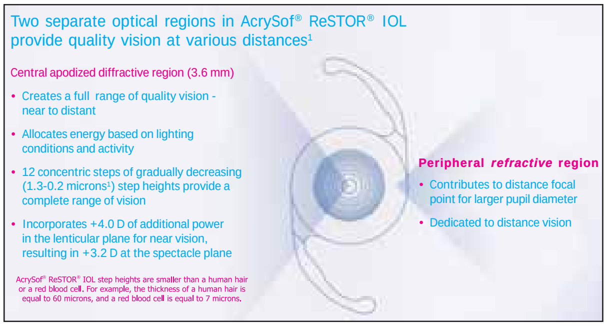

Figure 5

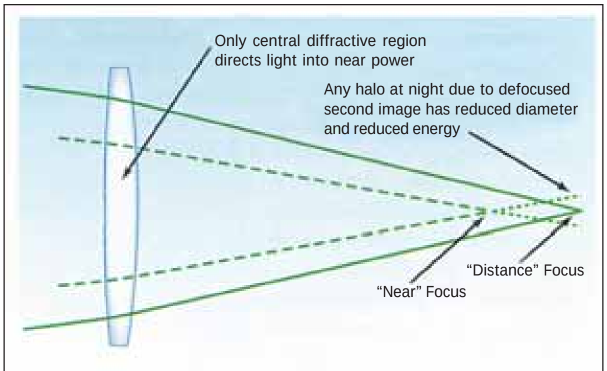

Figure 5. Limiting the diameter of the diffractive region reduces the size and energy of the halo surrounding a point source at night.

Figure 6

The Acrysof ReSTOR IOLs contains a unique optical system that combines a refractive IOL with an apodized diffractive component in the centre to provide patients with a range of vision. The lens provides one optical lens power for distance vision and a separate lens power for near vision in this system the brain chooses the image it wants to perceive and ignores the defocused image. The reason being that the defocused image is formed so far apart, that it does not create any problem for the brain to choose.

#Distance Vision: Light rays are parallel as they enter the eye from a distant object. The apodized Diffractive optic creates a clear image the retina while the near power creates a second, highly defocused image of the same image that is typically not perceived.

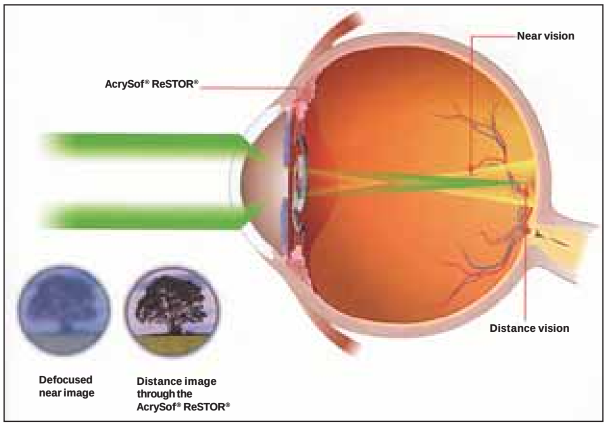

Figure 7

#Near Vision: Light rays from a near object diverge as they enter the eye. The +4 add creates a sharply focused image on the retina. The distance vision power creates a second, highly de-focused image which again, typically is not perceived.

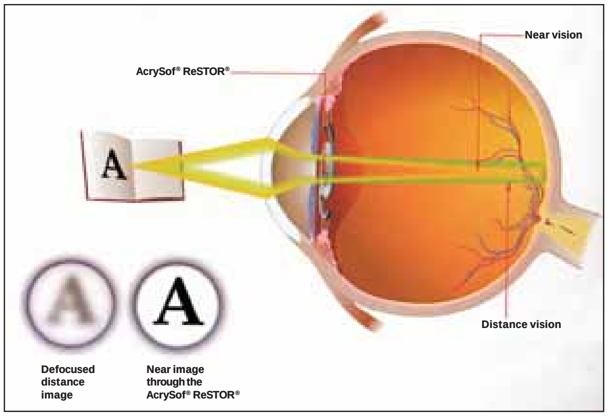

Figure 8

#Intermediate vision: Patients have to adapt to this.

#Pupil Size:

When the pupil is constricted the apodized diffractive system sends light waves simultaneously to both near and distance focal points. As lighting dims and the pupil dilates the lens sends a greater amount of energy to distance vision to improve vision quality while maintaining near energy, and minimizing visual disturbances.

In short the Acrysof ReSTOR IOLs contains a unique optical system that combines a refractive IOL with an apodized diffractive component in the centre to provide patients with a range of vision. The lens provides one optical lens power for distance vision and a separate lens power for near vision.

For distance vision, the image from the near lens power is highly defocused and very faint, and the eye typically sees only the focused distance image. Conversely, for near vision the image from the distance lens power is highly defocused and the eye sees only the near image.

Reducing the visibility of Halos at night was an important consideration in the ReSTOR design, which was accomplished through the apodization treatment to the central diffractive zone.

CALCULATING IOL POWER:

The most important investigation leading to a successful outcome. Aim for a +0.25 as with other Multifocals. Use all and any means to get a good IOL power calculation done. Use a new generation IOL calculation formula (SRK/T; Holladay 2; or Haigis). Since all the Acrysof ReSTOR users have to be familiar with single piece Acrysof implantation it is very important to personalize the A constant. A useful clinical tip is that the lens power chosen for the SA60D3 (ReSTOR) should be slightly lower than the emmetropic value that would be used for the SA60AT or SN60AT (Natural monofocal Acrysof).

IN A NUTSHELL

The Acrysof ReSTOR apodized diff IOL provides 2 primary lens powers through the combined optical effects of multiple small diffractive steps. The diffractive step heights decrease with increasing distance from the lens centre, and this gradually directs increasing energy into the distance lens power. This apodization design concept provides 2 major benefits:

1. Enhanced image intensity and enhanced contrast sensitivity at night when pupil diameter is large and

2. Minimization of any defocused light phenomena at night that come from the defocused second image.

Near vision with large pupils is rarely desired, and the benefits of the design are provided with little consequence to overall vision. All this is done on the Acrysof lens platform and the performance of the lens with respect to PCO formation is very well known to us.

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