Crystalens® & Dual Optic IOLs

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Disclosure

The speaker is a paid consultant to eyeonics® Inc.
Key Points

• Quality of vision is important and should not be sacrificed
• Vision is a binocular function and real-world results outperform monocular study results
• This debate is fun but surgeons should not take sides
Presbyopic Solutions

• Restore ability to see distance, intermediate and near without glasses
• Retain good quality of vision at all distances
• Avoid symptomatic visual problems, e.g., mesopic loss and driving glare
## Presbyopic Solutions

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<th>Accommodating IOL</th>
<th>Aspheric Cornea</th>
<th>Diffractive IOL</th>
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<tr>
<td><strong>Restore Distance / Int / Near Vision</strong></td>
<td>±</td>
<td>+</td>
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<tr>
<td><strong>Retain quality of vision</strong></td>
<td>+</td>
<td>-</td>
<td>-</td>
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<tr>
<td><strong>Avoid mesopic symptoms</strong></td>
<td>+</td>
<td>±</td>
<td>-</td>
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Reality v. the Ideal

• No current technology provides a complete solution
• Practitioners have the ability to enhance the technology performance
  – Partial monovision
  – “Split Head” solutions – different technologies in each eye
• Process requires surgeon to select the technology to match the patient’s needs
Accommodating IOLS’s Simulate Normal Physiology

• Nodal point optics
  – Fewer aberrations
  – Better Night Driving, etc.

• Avoids splitting image with resultant glare and contrast loss

• Permits binocular function at all distances, unlike monovision or corneal mono-asphericity
Multifocal
Refractive

Light Distribution 2 mm Pupil

Near  Intermediate  Far  Light Lost
37%   13%     50%  0%

Bifocal
Diffractive

Light Distribution 2 mm Pupil

Near  Intermediate  Far  Light Lost
40%   0%      40%  20%

focal points
Accommodating IOL: No Optical Loss
Current Accommodating IOL’s

• *Crystalens® AT-45 (First Generation)
• *Crystalens® SE (Square-Edge)
  – Square edge under haptic to decrease PCO
• Medennium Smart IOL
  – IOL replacement material
  – Expands to fill bag as temperature rises
• Synchrony IOL (Visiogen)
  – Dual optic IOL

* FDA Approved for use in the United States
Accommodating IOL Limitations

• Crystalens®: Range of accommodation is limited
  – Average 1.5 to 3 D
• Require more accurate refractive outcomes
  – Refractive errors undermine lens function
  – Approximately 1/3 will require refractive enhancement
• Technology is relatively new
  – Capsular Contraction with earlier models
  – Technology learning curve true of all the current solutions
Accommodating IOL’s

• Mechanism of Action combines movement, small optic with depth of field
  – Reports of backward pilo-induced accommodation disputed by Dell et al

• Holladay showed 4.5 mm optic provides approximately 1.5 D equivalent in depth of field

• Walz / Glasser work on accommodating arching suggests alternate mechanism
Anterior Chamber Depth
Optic Translation (Dell)

1% Cyclopentolate vs. 6% Pilocarpine

n=10 eyes

Movement range: 0.53mm-1.11mm  mean: 0.84mm
Accommodation in a Rhesus Monkey

Vilupuru, Roorda, and Glasser  Journal of Vision  April, 2004

Figure 4. Change in RMS error of the wave front aberration (excluding defocus) over an entrance pupil of 8 mm as a function of accommodative response calculated from the equation (2) term in the two eyes (eyes right eye, left eye of the rhesus monkey). Error bars represent 2 of one measurement each from five images captured at each amplitude. Accommodative responses and amplitudes for the two eyes are not identical and were achieved using different stimuli current for each eye.

1999, Roorda & Glasser, (1999, Roorda & Glasser, 1994a) Here we show an increase in negative spherical aberration with accommodation in vivo in the rhesus monkey eyes. Although perfect eyes are consistent on the basis of wave and convergent eyes (after passing through the cornea) are not on the basis of wave, the result, namely, increase in spherical aberration in the negative direction, is similar. The correlation between the results from the in vivo and in vitro monkey lenses and between the in vivo human and in vitro human lenses suggests that the in vivo data obtained in the current study in monkey eyes are also likely to apply to human eyes.

A prior study in humans suggested that the best near vision quality and consequently lowest aberrations occurred around the testing range of similar accommodation (He et al., 2000). In that study, however, higher order near abberations increased exponentially with accommodation at all accommodative states in the two eyes. The monkey eyes showed single negative spherical aberration in the unaccommodated state, which became progressively more negative with accommodation. Although aberrations in the monkey eye were measured through the contact lenses, the sign and amount of the positive spherical spherical aberration did not change significantly before and after placing the contact lenses on the corneas. Some human subjects in the He et al. study had positive spherical aberrations in the nonaccommodated state, and with accommodation, the spherical aberration would go from positive through zero to negative spherical aberration, which would minimize the total wavefront error at a widely accommodated state.
11 Year Old Phakic Subject

- Power Change
  - Greater in the center
  - Less in the peripheral
  - Not equal to change in SE
- Aberration
  - Increase in spherical
  - Increase in coma

UCDVA: 20/15  SE distance: +0.87  Pupil size distance: 4.8  Central Power Change: 1.97 D
UCNVA: J1+  SE near: -0.47  Pupil size near: 6.7  Accommodative Demand: 2.50 D
Depth of Field

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Focus @ 12.6 feet with F-stop 22 simulates Human Eye ~1.6 mm pupil (12 legible targets)
Focus @ 12.6 feet with F-stop 5.6 simulates Human Eye ~4.0 mm pupil (3 legible targets)
Focus @ 12.6 feet with F-stop 3.3 simulates Human Eye ~6.0 mm pupil
(1 legible target)
eyeonics® - DataLink IOL Registry

• Ongoing registry project to collect IOL outcomes
  – Recently added ability to accept and compare data for all IOL’s
• Direct surgeon access (no filtering)
• Current db has approximately 4000 eyes
  – Mostly Crystalens® to date
Binocular Acuity Results
All Eyes

UCVA 20/20

Distance: 21.4
Near: 29.6
ReSTOR Patient Brochure

Warnings
1. You may have some visual effects when several months following surgery. This may be
   more noticeable in areas with less light. Therefore, you should take extra care when driving at night.

ReSTOR eyes did worse than monofocal IOL’s for intermediate vision

20/40 or Better: 59% v. 82%, p < 0.05
Visual Function

• Any treatment based on multifocal effect compromises mesopic vision
  – Spherical aberration with hyper-prolate corneas
  – Diffractive IOL’s

• Night driving is a key factor for retaining and independent lifestyle

• Patients should be the ones to decide whether they will give up night driving, not the doctor
Reality Check

• Diffractive IOL’s and other vision-compromising technologies were designed when accommodating IOL’s didn’t exist

• They introduce unnecessary functional vision loss compared with accommodating IOL’s
Idea of mixing presbyopic lenses spurs debate

OSN convened a panel of refractive surgeons to discuss the use of two different IOL optical systems, as opposed to one.

With three presbyopia-correcting IOLs available and growing debate about their proper use, Ocular Surgery News held a round table discussion on the use of mixing two different presbyopia-correcting IOL optical systems in the same patient, as opposed to the use of only one. The expert panel discussed cases in which a physician might consider the use of two different systems, patient selection and education, and the advantages and disadvantages of the implantation of the same presbyopia-correcting IOL in each eye of a patient.

The panel discussion, which was moderated by Richard L. Lindstrom, MD, OSN Chief Medical Editor, begins on page 48.
Conclusions

• Surgeons can mix distance and “blend” monovision to achieve better vision quality with the Crystalens® than with any diffractive IOL

• Technologies can also be combined

• The debate is a good exercise, but surgeons should offer all solutions to their patients
Thank You!