Optics and Clinical Performance:

Extended Depth of Focus IOLs (and Multifocal)

Jack T. Holladay, MD, MSEE, FACS
Clinical Professor of Ophthalmology
Baylor College of Medicine
Houston, TX

Distance Definitions

<table>
<thead>
<tr>
<th>Distance</th>
<th>Add (D) Spectacles</th>
<th>Metric</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far</td>
<td>0</td>
<td>6 m</td>
<td>20 ft</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1.50</td>
<td>66 cm</td>
<td>26 inches</td>
</tr>
<tr>
<td>Near</td>
<td>2.50</td>
<td>40 cm</td>
<td>16 inches</td>
</tr>
</tbody>
</table>

Micro Monovision = plano & -0.50 D
Mini Monovision = plano & -1.25 D
Monovision = plano & “>” -1.50 D

Financial Disclosure

- I have the following financial interests or relationships to disclose:
  - Abbott Medical Optics: C
  - AcuFocus, Inc.: C,O
  - Alcon Laboratories, Inc.: C
  - ArcScan: C,O
  - Calhoun Vision: C,O
  - Carl Zeiss Inc: C
  - Elenza: C,O
  - Oculus, Inc.: C
  - Visiometrics: C,O

Optical Principles of IOLs

Refractive monofocal
- far focus

Diffractive
- near focus
- far focus

1st generation zonal refractive & EDOF
- near focus
- far focus

Visual Performance

Defocus Curves for Monofocal and Multifocal IOLs

Visual Acuity

Jack T. Holladay, MD, MSEE, FACS
**Extend Depth of Focus Lens**

- BSCVA of EDOF IOL at the peak value compared to the monofocal IOL control is < 0.1 logMar
- BSCVA of EDOF IOL needs to have 50% of patients better or equal to 20/32 (logMar 0.2) at 67 cm

**CORRECTION OF CHROMATIC ABERRATION**

- All corneas have a similar amount of chromatic aberration
- Proprietary Achromatic Technology is optimized to counteract the chromatic aberration of the cornea
- The net result is reduced chromatic aberration

**Symfny - EDF**

- CHROMATIC ABERRATION (450-700mm) (DIOPTER OF DISPERSION)

**IOL Optical Comparison**

<table>
<thead>
<tr>
<th>IOL Type</th>
<th>Theoretical BSCVA</th>
<th>Actual BSCVA</th>
<th>Contrast Loss</th>
<th>Halos &amp; Glare</th>
<th>Forward Light Scatter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspherical Mono</td>
<td>20/09</td>
<td>20/17</td>
<td>0%</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Spherical Mono</td>
<td>20/12</td>
<td>20/20</td>
<td>10%</td>
<td>+</td>
<td>0%</td>
</tr>
<tr>
<td>EDF 1.50 D</td>
<td>20/16</td>
<td>20/18</td>
<td>20%</td>
<td>+</td>
<td>10%</td>
</tr>
<tr>
<td>Diffractive Multi</td>
<td>20/20</td>
<td>20/22</td>
<td>25%</td>
<td>++</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>20/20</td>
<td>20/22</td>
<td>30%</td>
<td>+++</td>
<td>18%</td>
</tr>
</tbody>
</table>

LA Dodgers 1993-1995: 1.7% from 20/8.9 to 20/9.2

**Duo Chrome Test**

Hyperopic: N C K Z O
Myopic: R H S D K

SYMBOLOGY REPORT FOR SCIENCE

- Blue = -0.87
- Green = -0.37
- Yellow = 0.00
- Red = 0.37
- 0.84D
- 1.46D
- 1.98D

- Sensitivity to constant energy at each wavelength of the visible spectrum of the eye and cone sensitivity. (Table 5.7.7 from Report on Vision).
- Copyright 2002 American Academy of Ophthalmology. Reprinted with permission of The AAO Press; Cambridge, Massachusetts, 1996, p 8, fig 56.)
Optical & Clinical Performance of EDOFs & Multifocals 2018

Jack T. Holladay, MD, MSEE, FACS
**EDF IOL Conclusions**

- High Contrast BSCVA & CSF will be close to aspheric monofocal IOL
- CSF will be slightly less but not clinically significant (< 2 dB or 0.2 log)
- Intermediate: BSCVA 2.4 lines better
  UCVA 1.2 lines better
- Near: BSCVA 2.2 lines better
  UCVA 1.5 lines better
- Halos: 72% none, 12% some,
  9% quite a bit, 7% very
- No Glasses: 63% versus 32% (1/3 more)

<table>
<thead>
<tr>
<th>Presby Rx</th>
<th>Dom Eye DVA</th>
<th>Non-Dom Eye DVA</th>
<th>Binoc DVA</th>
<th>Dom Eye NVA</th>
<th>Non-Dom Eye NVA</th>
<th>Binoc NVA</th>
<th>3D</th>
<th>CS F</th>
<th>Halo</th>
<th>Glare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binocular Distance</td>
<td>20/20</td>
<td>20/20</td>
<td>20/16</td>
<td>20/40</td>
<td>20/40</td>
<td>20/30</td>
<td>9</td>
<td>+40%</td>
<td>2dB</td>
<td>--</td>
</tr>
<tr>
<td>Traditional Mono</td>
<td>20/20</td>
<td>20/40</td>
<td>20/20</td>
<td>20/40</td>
<td>20/25</td>
<td>20/25</td>
<td>6</td>
<td>0%</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Extended DOF</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/25</td>
<td>20/25</td>
<td>20/25</td>
<td>9</td>
<td>-21%</td>
<td>+1dB</td>
<td>1+</td>
</tr>
<tr>
<td>Multifocal 3 D Add</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>8</td>
<td>-37%</td>
<td>-2dB</td>
<td>2+</td>
</tr>
<tr>
<td>Multifocal 4 D Add</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>20/20</td>
<td>8</td>
<td>-37%</td>
<td>-2dB</td>
<td>3+</td>
</tr>
</tbody>
</table>

!Thank You!