Diffractive Multifocal Lenses after Corneal Laser Vision Correction

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CRISTIA SUNGA  BOptom

Financial Disclosure

<table>
<thead>
<tr>
<th>Company</th>
<th>Code</th>
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<tbody>
<tr>
<td>Abbott Medical Optics Inc.</td>
<td>S</td>
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<tr>
<td>Bausch + Lomb</td>
<td>C,L</td>
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<tr>
<td>Carl Zeiss Meditec</td>
<td>C</td>
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<td>Clarvista</td>
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<td>Ellex</td>
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<td>Excellens</td>
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<td>Medicem</td>
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<td>Nidek, Inc.</td>
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<td>Physiol</td>
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<td>PRN</td>
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<td>STAAR Surgical</td>
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<td>Strathspey Crown</td>
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<td>Scope Pharmaceuticals</td>
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<td>Rayner</td>
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C = Consultant / Advisor
E = Employee
L = Lecture Fees
O = Equity Owner
P = Patents / Royalty
S = Grant Support
Can Multifocals be used following LVC?

Considerations following LVC
- Demanding patients
- Induced aberrations
- ? Reduced contrast – visual quality
- Dry eye
- Predictability - Accurate lens calculations

Post Laser vision Correction

Induced aberrations
- Spherical aberrations – oblate cornea / small zones
  - Myopia - POSITIVE SA
  - Hyperopia NEGATIVE SA
- Coma – decentered treatments
Issues following LVC

• Biometry Error
  – ? Measurement of effective corneal power
  – Refractive surprises
    • Myopic LVC - hyperopic
    • Hyperopic LVC – myopic
  – Why ?
    • Instrument error (not designed for abnormal corneas)
    • ACD error
    • Refractive index change ?
    • Calculation formulas

Diffractive Lenses following LVC

• Do Cornea optics combine with diffractive lenses ?
  – Potential for reduced performance – intermediate / near
  – Visual quality issues ?

• Is there a high enhancement rate ?
  – Lens calculation error

• Are NEGATIVE SA lenses harmful post-Hyperopic LVC?
• Is visual quality adversely affected ?
Patients & Methods

- Retrospective study from Post LVC with Diffractive lenses 2007
- N= 102 eyes 59 patients
- Mean Age: 63 years (range 42 to 79)
- Male: Female 43:61 (eyes)

<table>
<thead>
<tr>
<th>EYES</th>
<th>Patient</th>
<th>BILATERAL</th>
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<tbody>
<tr>
<td>Hyperopic LVC:</td>
<td>44</td>
<td>24</td>
</tr>
<tr>
<td>Myopic LVC:</td>
<td>58</td>
<td>35</td>
</tr>
</tbody>
</table>

Patients and Methods

- LENS CALCULATION
  - Pentacam Holladay Report K readings
  - Holladay 2 Formula
- SURGERY
  - 1.8mm Microincisional cataract surgery (Stellaris MICS)

<table>
<thead>
<tr>
<th></th>
<th>MYOPIA</th>
<th>HYPEROPIA</th>
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<tbody>
<tr>
<td>FINEvision</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>FINEvision Toric</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>AT LISA Toric</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>AcriLisa bifocal</td>
<td>1</td>
<td>3</td>
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</table>
RESULTS – Refractive Outcomes

<table>
<thead>
<tr>
<th></th>
<th>PREOP (n=104)</th>
<th>1M (n=95)</th>
<th>3M (n=56)</th>
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</thead>
<tbody>
<tr>
<td>Sph Equivalent</td>
<td>-0.10 D ± 2.14 (range -7.50 to +3.50)</td>
<td>-0.11 D ± 0.50 (range -1.50 to +1.25)</td>
<td>0.03 D ± 0.77 (range -1.63 to 3.50)</td>
</tr>
<tr>
<td>Cylinder</td>
<td>0.56 D ± 0.48 (range -2.25 to 0.00)</td>
<td>0.41 D ± 0.46 (range -2.75 to 0.00)</td>
<td>0.46 D ± 0.45 (range -1.50 to 0.00)</td>
</tr>
</tbody>
</table>

PREDICTABILITY

Scatter: Attempted vs. Achieved SEQ 'PREDICTABILITY'
95 eyes - 1 m postOP

Scatter: Attempted vs. Achieved SEQ 'PREDICTABILITY'
56 eyes - 3 m postOP
Refractive outcome

Refractive outcome - Percentage within Attempted

- ± 0.50 D: 68%
- ± 1.00 D: 91%

UDVA

Cumulative UDVA - Percentage

Binocular Cumulative UDVA - Percentage

Sheraz Daya, MD

CENTRE FOR SIGHT
UIVA 80cm

Cumulative UIVA @80 - Percentage

- 1 m (31)
- 3 m (30)

- 11%
- 32%
- 41%
- 66%
- 93%
- 93%
- 96%
- 100%

- 3%
- 7%
- 9%
- 13%
- 17%
- 32%
- 34%
- 48%

Biocular UIVA @80 - Percentage

- 1 m (36)
- 3 m (30)

- 11%
- 32%
- 41%
- 66%
- 93%
- 93%
- 96%
- 100%

- 3%
- 7%
- 9%
- 13%
- 17%
- 32%
- 34%
- 48%

SAFETY

Change in CDVA - Percentage 'SAFETY'

- 1 (95)
- 3 (56)
**ASTIGMATISM**

Scatter: Attempted change in CYL vs. SIRC 1 m postOP

Scatter: Attempted change in CYL vs. SIRC 3 m postOP

**Q values post LVC**

- **Hyperopic**
  - Q value  | Mean  | SD    | Range
  - Pentacam (n=29) | -0.521 | 0.303 | -0.06—1.50
  - OPD 3 (n=29) | -0.516 | 0.239 | -0.17—1.129

- **Myopic***
  - Q value  | Mean  | SD    | Range
  - Pentacam (n=26) | +0.271 | 0.461 | -0.20 to -1.11
  - OPD 3 (n=25) | +0.322 | 0.547 | -1.129 to -2.02

* 1 eye “blended vision”
### Corneal Aberrations

- **Hyperopic**

<table>
<thead>
<tr>
<th>OPD 3 4mm</th>
<th>SA</th>
<th>COMA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.074</td>
<td>0.237</td>
<td>0.392</td>
</tr>
<tr>
<td>SD</td>
<td>0.0717</td>
<td>0.188</td>
<td>0.284</td>
</tr>
<tr>
<td>Range</td>
<td>0.013–0.242</td>
<td>0.078–0.825</td>
<td>0.087–1.296</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PENTACAM</th>
<th>SA</th>
<th>HOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.148</td>
<td>0.601</td>
</tr>
<tr>
<td>SD</td>
<td>0.105</td>
<td>0.172</td>
</tr>
<tr>
<td>Range</td>
<td>0.066 to 0.312</td>
<td>0.512–1.068</td>
</tr>
</tbody>
</table>

- **Myopic**

<table>
<thead>
<tr>
<th>OPD 3 4mm</th>
<th>SA</th>
<th>COMA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.139</td>
<td>0.261</td>
<td>0.404</td>
</tr>
<tr>
<td>SD</td>
<td>0.133</td>
<td>0.346</td>
<td>0.456</td>
</tr>
<tr>
<td>Range</td>
<td>0.023–0.513</td>
<td>0.037–0.806</td>
<td>0.900–1.027</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PENTACAM</th>
<th>SA</th>
<th>HOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.788</td>
<td>1.215</td>
</tr>
<tr>
<td>SD</td>
<td>0.252</td>
<td>0.401</td>
</tr>
<tr>
<td>Range</td>
<td>0.591–1.046</td>
<td>0.891–1.821</td>
</tr>
</tbody>
</table>

### Hyperopia (n=45) vs Myopia (n=59)

<table>
<thead>
<tr>
<th></th>
<th>PREOP (n=45)</th>
<th>1M (n=43)</th>
<th>3M (n=28)</th>
<th></th>
<th>PREOP (n=59)</th>
<th>1M (n=52)</th>
<th>3M (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPH EQUIV</strong></td>
<td>0.98 D ± 1.51</td>
<td>-0.15 D ± 0.46</td>
<td>-0.00 D ± 0.87</td>
<td><strong>SPH EQUIV</strong></td>
<td>-0.93 D ± 2.19</td>
<td>-0.08 D ± 0.53</td>
<td>0.06 D ± 0.66</td>
</tr>
<tr>
<td></td>
<td>(range -5.88 to +3.50)</td>
<td>(range -1.00 to +1.25)</td>
<td>(range -0.75 to +3.50)</td>
<td></td>
<td>(range -7.50 to +2.00)</td>
<td>(range -1.25 to +1.75)</td>
<td>(range -1.63 to 1.50)</td>
</tr>
<tr>
<td><strong>CYL</strong></td>
<td>0.56 D ± 0.42</td>
<td>-0.54 D ± 0.51</td>
<td>-0.57 D ± 0.51</td>
<td><strong>CYL</strong></td>
<td>-0.56 D ± 0.52</td>
<td>-0.29 D ± 0.38</td>
<td>-0.35 D ± 0.36</td>
</tr>
<tr>
<td></td>
<td>(range -2.00 to 0.00)</td>
<td>(range -2.75 to 0.00)</td>
<td>(range -1.50 to 0.00)</td>
<td></td>
<td>(range -2.25 to 0.00)</td>
<td>(range -1.50 to 0.00)</td>
<td>(range -1.00 to 0.00)</td>
</tr>
</tbody>
</table>
Hyperopic vs Myopic Diffractive post LVC

Refractive outcome - Percentage within Attempted

± 0.50 D: 64%
± 1.00 D: 93%

Monocular UDVA

Cumulative UDVA - Percentage

Hyperopic vs Myopic Diffractive post LVC

Monocular UDVA

Cumulative UDVA - Percentage

± 0.50 D: 71%
± 1.00 D: 89%
Hyperopic vs Myopic LVC – Binocular UDVA

Hyperopic vs Myopic LVC
UNVA(40cm) Binocular
Hyperopic vs Myopic LVC
Safety

Change in CDVA - Percentage 'SAFETY'

Hyperopic vs Myopic LVC - Contrast

Contrast Sensitivity Hyperopic LVC
Contrast Sensitivity Myopic LVC

Spatial Frequency [cycles/degree]
pre op (6) 1 m (15) 3 m (9)
Interventions

- **Enhancements** 6 eyes (6%)
  - 3 Lasik (2 prev Hyperopia, 1 myopia)
  - 1 PRK (prev myopia)
  - 2 piggyback lenses (H Lasik)

- **Decentered Trifocal** 1 eye
  - Required re-centration

- **Explantations** 0 eyes

- **YAG Capsulotomies** 6 eyes

Diffractive Lenses following LVC

- **Did Corneal optics combine with diffractive lenses?**
  - YES – good performance – better in Hyperopic LVC

- **Was there a high enhancement rate?**
  - 7% in this study

- **Were NEGATIVE SA lenses harmful in post Hyperopic LVC?**
  - no impact – Hyperopic LVC did better than myopes!

- **Was visual quality adversely affected?**
  - Contrast sensitivity good at 3 months in both groups- Hyperopic LVC did better
  - No patient complaints – all spectacle free
Conclusions

• Diffractive lenses can be used in patients following Corneal Ablative Refractive Surgery

• Consider aberrations at 4.0mm rather than 6.0mm

• Holladay Report / Holladay 2 – accurate IOL calculation

• Careful patient selection and counselling – recommended

Thank you ...