Phase-Plate Correction of Pseudo-Emmetropes with Minimal Adaptation

Lawrence Sverdrup, Ph.D.

Ophthonix, Inc.
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Outline

• Design of clinical trial
• Results
• Comparison with related studies
• Discussion
Acknowledgement

Andreas Dreher, Ph.D.
Shui Lai, Ph.D.
Wade Stapp
Subjects

38 pseudo-emmetrope subjects (76 eyes) who did not wear any form of vision correction

Subjects with LASIK surgery were included

Minimum visual acuity of 20/25

Age: 19 – 60 (median=33.4 years)

Eyes outside dynamic range of polymer excluded
Procedure

• Three wavefront measurements taken for each eye, 2\textsuperscript{nd}-6\textsuperscript{th} order Zernike polynomials
• Wavefront correcting cells were created for mesopic pupils
  – Mean and Std. Dev. were calculated for each Zernike coefficient
  – Zernike parameters were excluded if 95% confidence interval included “0”
• RMS accuracy of correction ≥ 90%
• Trial frame built with pupil alignment
Procedure

• Two sets of cells – wavefront correction (WFC) and placebo – were tested on the subjects
• The use of the placebo or the WFC cells was masked from the tester and the subject
• 17 eyes were tested twice with the placebo
• Natural pupils
• Oversized apertures to force vision through WFC zone
Randomized Procedure

- One of 8 schemes was randomly chosen by a third person.

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<th>Test 1</th>
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<th>Test 2</th>
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P = Placebo
WFC = Wavefront Corrected
Vision Tests

- Vector Vision CSV-1000 vision testing instrument, each eye was tested separately, multiple charts used to prevent memorization.
- ETDRS-1/2 test face for High Contrast Visual Acuity (HCVA).
- ETDRS-R test face with 10% contrast for Low Contrast Visual Acuity (LCVA).
- NEI letter counting method.
- CSV-1000E Contrast Sensitivity @ 3, 6, 12 & 18cpd.
Correction of Spherical Equivalent Immediately Improves Vision

Trend is statistically significant $P < 0.01$

5 hyperopic eyes not included
Correction of Spherical Equivalent Immediately Improves Vision

Trend is statistically significant $P < 0.05$

5 hyperopic eyes not included

HCVA Difference vs Spherical Equivalent

$y = -1.2422 + 6.0321x \quad R = 0.31678$
Correction of Astigmatism Does Not Immediately Improve Vision

LCVA Difference vs Astigmatism

\[ y = 2.0107 + 0.44463x \quad R^2 = 0.015723 \]
Correction of Astigmatism Does Not Immediately Improve Vision

HCVA Difference vs Astigmatism

y = 0.40443 + 0.79214x  R = 0.029001
Correction of Astigmatism Does Not Immediately Improve Vision

\[ \Delta CS@18\text{cpd} \text{ vs Astigmatism} \]

\[ y = 0.44711 - 0.23769x \quad R = 0.021159 \]

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Expected Impact on Vision with No Adaptation Effects

<table>
<thead>
<tr>
<th>Letters Lost per µm rms @6mm</th>
<th>C₂,-2</th>
<th>C₂,0</th>
<th>C₂,+2</th>
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</thead>
<tbody>
<tr>
<td>HCVA</td>
<td>-30.9</td>
<td>-40.0</td>
<td>-32.9</td>
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<tr>
<td>LCVA</td>
<td>-28.2</td>
<td>-52.0</td>
<td>-16.4</td>
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<tr>
<th>Letters Lost per Diopter of Equivalent Defocus</th>
<th>C₂,-2</th>
<th>C₂,0</th>
<th>C₂,+2</th>
</tr>
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<tbody>
<tr>
<td>HCVA</td>
<td>-23.8</td>
<td>-30.8</td>
<td>-25.3</td>
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<tr>
<td>LCVA</td>
<td>-21.7</td>
<td>-40.0</td>
<td>-12.7</td>
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Results

• Correction of Spherical Equivalent provides some immediate improvement in vision

• Correction of Astigmatism does not provide a significant immediate improvement in vision
Comparison with Related Studies

• Patients are adapted to their aberrations – Adaptive Optics for Vision: The Eye’s Adaptation to PSF, P Artal et al., JRS Vol. 19 (2003) pp. S585-S587
• Prediction that immediate benefit of vision correction will be reduced – Neural compensation for the best aberration correction, L Chen et al., J Vis, Vol 7(10) (2007) pp. 1-9
Discussion

• Results explain at least some of the difficulty of refraction for astigmatism
• An accurate manual refraction is time consuming
• Correction of off-axis terms must allow time for adaptation to provide vision benefit
• Illustrates the value of a wavefront refraction such as that provided by the Z-View® Aberrometer
Appendix
Correction of Spherical Equivalent Immediately Improves Vision

Trend is statistically significant $P < 0.001$

\[ y = 0.57151 - 6.2882x \quad R = 0.4815 \]
Correction of Spherical Equivalent Immediately Improves Vision

Trend is statistically significant $P \approx 0.02$

$y = -1.0552 + 4.8347x \quad R = 0.30395$