RAY-TRACING MEASUREMENT OF OPTICAL PROPERTIES CONTRIBUTING TO DYNAMIC ACCOMMODATIVE POWER AFTER LASER ANTERIOR CILIARY EXCISION

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Financial Disclosure:
Author 1 & 2 have received research funding and travel expense reimbursement from Ace Vision Group, Inc.
Authors 3, and 4 have no financial interest.
SPHERICAL ABERRATION AND AGE

• Corneal spherical aberration (SA) is stable with age
• The aging crystalline lens becomes less negative (or even more positive)
• The total optical SA increases by adding to the positive corneal SA
Depth of Focus (DOF): range of defocus error that degrades the retinal image quality.
SPHERICAL ABERRATION AND DEPTH OF FOCUS

- Both positive and negative spherical aberration expands the DOF.
- DoF curve strongly increased (up to 2D) as spherical aberration was increased to +/-0.6microns.
RAY-TRACING EVALUATION OF PSEUDO VS TRUE ACCOMMODATION IN PATIENTS S/P LASER ANTERIOR CILIARY EXCISION

Purpose: Define changes in spherical aberration, Coma, Trefoil, and defocus during dynamic accommodation in patients following a procedure for presbyopic restoration.

- 6 presbyopia patients underwent bilateral laser anterior ciliary excision.
- iTrace measurements were performed at distance and 40 cm to assess accommodative ability.
LASER ANTERIOR CILIARY EXCISION

- **Theory:** Scleral excisions in 3 physiologically critical zones partially restores biomechanics of the accommodative system.

- **Procedural objective:**
  - Restore mechanical efficiency of the natural accommodative mechanism.
  - Improve biomechanical mobility to achieve accommodative power

- **Procedural Methods:**
  - Nine excisions per quadrant
  - 600µm spot size in mathematical diamond matrix pattern using Er:Yag laser with fiber optic probe
  - Each matrix performed in four oblique quadrants
OBJECTIVE MEASUREMENT OF TRUE ACCOMMODATION

- The iTrace (Houston, TX) objectively measures refraction and HOAs.
- A refractive difference between distance and near refraction demonstrates true accommodation.
The iTrace compares HOAs at distance and near to determine the change in aberrations: total eye, coma, spherical aberration, trefoil, and secondary astigmatism.
DYNAMIC WAVEFRONT ANALYSIS OF ACCOMMODATION

- Six patients S/P laser anterior ciliary excision were evaluated:
  - 3 short-term patients (0-6 months)
  - 3 long-term patients (6-8yrs)
- ITrace difference maps were created for each patient

<table>
<thead>
<tr>
<th>Difference Distance to Near BCVA</th>
<th>Mean Rx</th>
<th>Total Aberration</th>
<th>Total HOA</th>
<th>Spherical Ab</th>
<th>Coma</th>
<th>Trefoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 6</td>
<td>0.04</td>
<td>0.15</td>
<td>0.11</td>
<td>-0.011</td>
<td>0.06</td>
<td>0.0005</td>
</tr>
<tr>
<td>SD</td>
<td>± 0.03</td>
<td>± 0.08</td>
<td>± 0.07</td>
<td>± 0.021</td>
<td>± 0.05</td>
<td>± 0.007</td>
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</tbody>
</table>
SPHERICAL ABERRATION AND DEPTH OF FOCUS

- Specific HOA have a greater impact on depth of focus, visual acuity and quality
- SA shifts toward negative values during accommodation

LaserACE patient 8 years after procedure.
Note the reduction in hyperopia while viewing the 40 cm target and change in spherical aberration.
CONCLUSIONS

• Ray-tracing technology can objectively measure dynamic accommodation and is a critical device to differentiate true accommodation from pseudo-accommodation.

• Specific optical correlations were identified during dynamic accommodation pre-op/post-op LaserACE which may explain the improvement in dynamic accommodative capacity and visual acuity in these patients.