RECENT ADVANCES IN CORNEAL CORRECTION OF PRESBYOPIA

SAMEH ELHELW MD, PHD
CORNEA AND REFRACTIVE SURGERY CONSULTANT
REFRACTIVE SURGERY CLINIC
ALEX, EGYPT

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Corneal Presbyopic Correction

Surgeons have tried many combinations of keratorefractive reshaping techniques in an attempt to give patients near and distance-viewing zones on the cornea.

Recently, there has been significant progress in procedural options for the cornea-based surgical correction of presbyopia.
Corneal Presbyopic Correction

• **LASER SURGERY:**
  • Near Vision in the Center, Distance Vision in the Periphery.
  • Distance Vision in the Center, Near Vision in the Periphery.
  • Annular Ablations.
  • The Aspheric Hyperprolate Profile.
  • Two-Step Ablations.
  • Flapless Intrastromal Ablation.
  • Multifocal Ablation.
  • Non-Linear Aspheric Ablation.

• **NON LASER SURGERY:**
  • Intracorneal Inlays and Onlays.
  • Conductive keratoplasticity (CK).

• **MONOVISION**
• Near Vision in the Center, Distance vision in the Periphery (PRESPY LASIK).

• Patented VISX™ omni-focal aspheric ablation profile.

• Combination of the pupil-size dependent central zone (Near), peripheral zone (Far) and LASIK flap produces an aspheric curve that expands the depth of focus.
Pre-Operative

OS

25-Jan-2007 18:28:21

Pre-operative

-1.22 DS - 0.53 DC x 176° @ 12.5 mm (4.00 Rx Calc)

W.F. Diam (mm): 6.00

High Order: 27.0 %

Eff. Blur (D): 0.95

Rms Err (μ): 1.23

Quality: ✔ ✔ ✔ ✔

Eye Image

Limbus Diam: 12.3 mm

Pupil: 6.2 x 6.0 mm @ 80° (avg 6.1)

All Order Aberrations - Log 50%

Eff. Blur (D): 0.95

Range: -15.0 to +15.0 minutes of arc

Wavefront High Order Aberrations

Rms Error (μ): 0.40

Normalized Polar Zernike Coefficients (μ)

<table>
<thead>
<tr>
<th>Value</th>
<th>Name</th>
<th>Value</th>
<th>Name</th>
<th>High Order Aberrations Graph</th>
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<tr>
<td>0.0</td>
<td>Defocus</td>
<td>0.0</td>
<td>Astigmatism</td>
<td>0.33714</td>
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<tr>
<td>0.010053</td>
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<td>Coma</td>
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<td>0.04788</td>
<td>32°</td>
<td>Astigmatism</td>
<td>0.04788</td>
<td>32°</td>
</tr>
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</table>

Range: -1.4 to +1.2 microns

Grid spacing: 1 mm.
Post-Operative

OS
+0.14 DS -0.52 DC x 137° @12.5 mm (4.00 Rx Calc)
31-Jan-2007 13:12:40 W.F. Diam (m): 5.50 High Order: 56.7 %
Eff. Blur (D): 0.56 Rms Err.(μ): 0.61 Quality: 

Eye Image Limbus Diam: 12.5 mm Pupil: 6.0 x 5.9 mm @71° (avg 5.9)

All Order Aberrations - Log 50%
Eff. Blur (D): 0.56

Wavefront High Order Aberrations
Rms Error (μ): 0.30

Normalized Polar Zernike Coefficients (μ)

<table>
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<th>Value</th>
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<td>0.39257</td>
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<td>-0.20861</td>
<td>Sph. Aberration</td>
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</table>
• Distance Vision in the Center, Near Vision in the Periphery.

Decentered steep central island.

Both distance and near vision were negatively affected

Not be improved further by spectacles.
Annular Ablations.

Intermediate plus near midperipheral ablation pattern to the cornea.

It is still being studied.

Results in poor distance and near vision that cannot be corrected by glasses.
The Aspheric Hyperprolate Profile. (GLOBAL OPTIMUM)
Alegretto eye Q by Wavelight

– Maintain corneal physiological pre-op condition at first place.

– Hyper-prolate cornea, increasing depth of focus → Global optimum

– Enhanced monovision
Asphericity – adjusted Treatment  
( Custom Q )

Before Lasik

After Lasik

Hyperopia

Post Operative Topography

Q optimized vs Global Optimum
Two-Step Ablations.

Try to create negative asphericity on the cornea to improve near acuity.

Involves using two treatments, one for a myopic ablation and one for a hyperopic ablation.

The effect is highly pupil-dependent.

Still in premarket studies.

Questions about visual quality postoperatively and amount of aberration of the cornea.
- **Flapless Intrastromal Ablation.**
  
  **Technolas Perfect Vision**

The *IntraCOR* procedure is an intrastromal application of the FEMTEC femtosecond laser.

It uses a specific algorithm to create five concentric stromal rings at a predetermined distance from each other and from the corneal epithelium and endothelium.

The design of the cuts and their depth in the stroma depend on the eye’s refraction and pachymetry.
Results from, ongoing study in Germany show a mean gain of 4.42 lines of UCVA at near.

No statistically significant difference in distance vision.
Intrastromal Ablation
SUPRACOR

• It uniquely combines features for remodeling of the cornea for far, near and intermediate visual acuity. It is also referred to as Blended Vision, Multi-Focal or Bi-Focal laser.

• Effective in correcting presbyopia in hyperopic patients.

• Patients have similar vision in both eyes for distance and near, so that binocular vision is not affected.
PresbyMAX® module by Shwind

Jorge L. Alió, MD, PhD (Spain)

- Based on bi-aspheric, multifocal ablation profiles. It optimizes the central corneal area for near vision and the midperipheral cornea for far vision.

- Binocular vision.

- Enlarges the depth of focus and minimizes contrast losses.

- Myopia, hyperopia and astigmatism can be combined with presbyopia corrections in only one step.
• Correction of these visual defects can be performed as “Aberration-Free” or “Customized” treatments.

• Multifocality, created with biaspheric ablation profiles based on optimized mathematic curves, provides adequate transitions between far and near vision.
Non-Linear Aspheric Ablation Micro-monovision with the Carl Zeiss Meditec MEL80 platform.

Reinstein DZ, MD (England)

• This hyperopic micro-monovision protocol was a well-tolerated and effective procedure for treating patients with presbyopia in moderate to high hyperopia with corrections ranging up to +5.75 D.

• Contrast sensitivity was improved and the distance vision of near eyes was found to contribute positively to binocular distance vision compared to distance eyes monocularly.
Micro-monovision
• **Intracorneal Inlays and Onlays.**

Implantable devices that are surgically inserted just under the superficial layers of the cornea. It alter the way light enters the eye. So, near vision is improved.

• **The ACI 7000 corneal inlay (AcuFocus and Bausch & Lomb),** corrects presbyopia by controlling the amount of light that enters your eye and increasing the range of what you see in focus.
• **InVue intracorneal microlens (Biovision, Brügg, Switzerland),** which is placed in a tiny tunnel in the center of the cornea.

• **PresbyLens (ReVision Optics, Lake Forest, Calif.),** an ultra-thin lens implanted in the cornea.

• **Presbia Flexivue System (Presbia Coöperatief U.A., Amsterdam),** which uses a femtosecond laser to create a tiny "pocket" into which a micro-lens is inserted.

• **Corneal onlays**
  Collagen-like lens material placed in a pocket under the outer layer of the cornea to achieve better focus. Lasers also may be used to reshape this material to refine focus without altering the eye itself.
• **Conductive keratoplasty (CK).**

• Apply low-level, radio frequency (RF) energy to specific spots that form a circular pattern on the outer part of the cornea.

• Connective tissue then shrinks where the RF energy was applied, causing the circular band to act like a belt that "tightens" and steepens the cornea.

• This change in the curvature of the eye's surface affects the way light rays enter the eye to bring near vision back into focus.
Monovision: Tried and True.

Still remains the most successful presbyopic treatment to date that does not change the patient’s visual perspective.

One eye corrected for distance and one eye corrected for near.

The most common complaint from this procedure is nighttime glare in the reading eye.

It can be fully corrected either with spectacles or corneal refractive surgery.
CONCLUSIONS

• Corneal surgery is an excellent option.

• Minimally invasive approach to be a more attractive option than intraocular surgery.

• Some disadvantages are noted, but they are treatable and minor compared with other presbyopia correction techniques. Reversibility makes this surgical option the best to offer.

• In patients older than 55 years of age, presbyopia-correcting IOLs considered and binocular correction achieved.
Thank You