M7 Excimer Laser in refractive surgery

Lucky Hsu
Radial Keratotomy (RK)

In 1970
History of Laser Vision Correction

Photo-refractive Keratectomy (PRK)
In 1987
History of Laser Vision Correction

Laser In-Situ Keratomileusis

LASIK

In 1993
Typical excimer laser in refractive surgery market

Alcon (Wavelight)  B&L (Technolas)
How do typical refractive excimer laser apparatus work?

1. Fixed optical set up
2. XYZ table movement
3. Eye tracker
The disadvantages of traditional excimer laser apparatus

1. An eye tracker can not fix the problem that visual axis and laser beam are not co-axis.
2. Spending a lot of more time to adjust the table to fit with the surgery position.
3. General big sized it is difficult to arrange a femtosecond laser around.
4. The lens effect reduces the quality of the outcome, especially in the edge of cornea.
What can we improve?

• 25 years of development of excimer laser systems for refractive surgery.

• What if the “size” of the laser could be like a TEA cup that you can manage in your hand?
Imagine

- What is the difference of a typical excimer laser design and the Excelsius’ new excimer laser design?

- If the operated unit can be designed as a tea cup, there are some expected improvements.
(1) Laser to the eye

- It does not need a three axis fancy patient table to move the patient’s eye looking for the laser beam.
(2) Laser has direct eye contact

Typical excimer laser

Excelsius New Excimer Laser
(3) Parallel Laser Beam

MUCH MORE EFFICIENCY
A revolution methodology - M7

1. **Virtual laser blade**: the first excimer laser in refractive surgery that uses the handpiece to deliver the laser beam

2. **Parallel scanning laser delivery**: precise laser spot and energy at the edge of the cornea

3. **Dynamic harmonization with eye movement**: the surgery apparatus and the eye are harmonized by contact and assisted by eye pupil monitoring

4. **Comprehensive surgical plan**: the laser beam delivery algorithm is based on a homogeneously randomized flying spot laser beam distribution method that accounts for possible refractive errors with a simple surgical plan screen
The versatile of M7 - Presbyopia treatment
Presbyopia

• Presbyopia is caused by an age-related process.
• During middle age, usually beginning in the 40s, people experience blurred vision at near points.
• Presbyopia is a gradual loss of flexibility in the natural lens inside your eye.
• These age-related changes occur within the proteins in the lens, making the lens harder and less elastic with the years.
• Age-related changes also take place in the muscle fibers surrounding the lens.
PresbyLASIK

Two main techniques for presbyopia treatment:

1. **Monovision** - one eye is corrected for distance while the other eye is corrected for near vision

2. **Multifocal cornea ablation**
   i. Central presbyLASIK
   ii. Peripheral presbyLASIK
Monovision

• Most common but patient selection is critical
• The dominant eye gets usually corrected for distance vision
• Slight decrease in binocular distance vision, contrast acuity and stereopsis
• **M7** uses a low degree of asphericity in *emmetropic patients* since it is able to increase the depth of field and maintain good distance vision by monovision
Central presbyLASIK (near vision in the center)

• Mechanism: a hyper-positive area is created at center of the cornea for near vision, while the periphery provides focus for distance.

• Indications: for initial and moderate presbyopia

• VISX/AMO, Schwind, Technolas

• A study showed that central presbyLASIK has a mean increase of 0.73D in the amplitude of accommodation of hyperopic presbyopia, which is more than the peripheral presbyLASIK that has a mean increment of 0.69D.

## Central presbyLASIK

<table>
<thead>
<tr>
<th>Treating presbyopic hyperopes</th>
<th>Schwind PresbyMAX</th>
<th>Technolos SUPRACOR</th>
<th>VISX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment type</td>
<td>Symmetric- DE and NDE equally regarding depth of focus and the refractive target. μ-monovision- the same depth of focus in both eye. DE focuses slightly more on distance while NDE focuses slightly more towards Hybrid- DE and NDE have different depth of focus and refractive target.</td>
<td>Bilateral Asymmetric Treatment- Spherical Equivalent (SE) Target = -0.5 D Sensory Dominant Eye : Target 0.0 D Sensory Non-Dominant Eye: Target -0.5 D</td>
<td>Aspheric ablation profile- 1. The diameter of the central zone is proportional to the mesopic pupil size to keep the ratio of the “near vision zone” and the “distance vision zone” roughly constant across patients 2. The area of the distance vision zone is four times larger than the central near vision zone</td>
</tr>
<tr>
<td>Multifocal pattern</td>
<td>Bi-aspheric centre near and peripheral distance</td>
<td>Centre near and peripheral distance</td>
<td>Aspheric centre near and peripheral distance</td>
</tr>
<tr>
<td>Refraction</td>
<td>SEQ: -8.00 to +8.00; Ast: -6.00 to +6.00; Add: +0.25 to +3.00</td>
<td>MRSE +0.75D to +4.0 D Astigmatism &lt; 2.0 D Near Add &gt; 1.75 D</td>
<td>MRSE ≤+4.00 D Astigmatism ≤+1.50 D Near Add &gt; 1.25 D</td>
</tr>
</tbody>
</table>
## Central presbyLASIK

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Remove less amount of corneal tissue than peripheral presbyLASIK</td>
<td>1. Variability- different result with same laser program</td>
</tr>
<tr>
<td>2. Can be used for correcting presbyopia in myopes, hyperopes and emmetropes</td>
<td>2. Hyperopic patients more satisfied- myopes more spectacle dependence</td>
</tr>
<tr>
<td>3. Pupil constriction, associated with near vision, enhances the effects of the central near correction</td>
<td>3. Manage tear and meibomian gland dysfunction</td>
</tr>
<tr>
<td>4. Providing greater freedom from reading glasses than distance center approaches</td>
<td>4. Lack of coincidence between the visual axis, pupil center and corneal vertex during centration and lead to induction of coma aberrations.</td>
</tr>
</tbody>
</table>
Peripheral presbyLASIK (distance vision in the center)

- **Mechanism**: the central area of cornea is assigned for distance vision, while the peripheral cornea provides a focus for near by creating negative peripheral aspericity.
- **Indications**: myopes, hyperopes and emmetropes.
- **VISX/AMO, Technolas, Nidek, Wavelight**
## Peripheral presbyLASIK

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Can be used in both myopes and hyperopes</td>
<td>1. More neuro-adaptation required-distance vision slower to recover</td>
</tr>
<tr>
<td>2. Increased depth of field (The combination of the pupil-size dependent central zone, and the LASIK flap produces an aspheric curve that expands the depth of field)</td>
<td>2. Longer treatments, more tissue removed</td>
</tr>
<tr>
<td></td>
<td>3. Night vision disturbances reported</td>
</tr>
<tr>
<td></td>
<td>4. Myopes more satisfied than hyperopes</td>
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<td></td>
<td>5. This ablation profile is more influenced by pupillary diameter:</td>
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<tr>
<td></td>
<td>a. when pupil constricts, near vision is degraded.</td>
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<tr>
<td></td>
<td>b. when pupil dilates, distance vision is compromised.</td>
</tr>
</tbody>
</table>
## Presbyopia mode of M7

<table>
<thead>
<tr>
<th>Presbyopia type</th>
<th>Myopic presbyopia</th>
<th>Emmetropic presbyopia</th>
<th>Hyperopic presbyopia</th>
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<tbody>
<tr>
<td><strong>Indication</strong></td>
<td>Sphere $\leq -7.00$ D, and cylinder $\leq -2.50$ D. spherical equivalent refraction $\leq +4.50$ D</td>
<td>Manifest sphere $\leq +1.00$ D, and manifest cylinder $\leq +1.25$ D. spherical equivalent refraction $\geq -0.88$</td>
<td>Sphere $\leq +4.50$ D, and cylinder $\leq +1.50$ D. spherical equivalent refraction $\leq +4.50$ D</td>
</tr>
<tr>
<td><strong>Ablation pattern</strong></td>
<td>Peripheral presbyLASIK</td>
<td>Monovision- aspherical</td>
<td>Central presbyLASIK</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Distance vision is through the centre of the cornea and near vision in the periphery</td>
<td>Dominant eye for emmetropia and the non-dominant eye for $-0.75$ D to $-2.25$ D of myopia</td>
<td>Near vision is through the centre of the cornea and distance vision in the periphery (target emmetropia for DE and $-0.50$ NDE)</td>
</tr>
<tr>
<td><strong>Pupil size</strong></td>
<td>DE: 5 mm NDE: 4.5 mm</td>
<td></td>
<td>3 mm</td>
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<tr>
<td><strong>Near add</strong></td>
<td>$+3.0$ D</td>
<td></td>
<td>$+2.0$ D</td>
</tr>
</tbody>
</table>

Note: The treatment of mixed astigmatism is not intended in this plan since its complicated pattern and enormous ablation volume.
Thank you very much for your attention