Laser Vision Correction

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History of Corneal Refractive Surgery

- Radial Keratotomy - 1974 - Svyatoslav Fyodorov - Russian Ophthalmologist
History of corneal refractive surgery

- 1987- Theo Seiler- German Ophthalmologist performed the first photorefractive keratectomy
History of corneal refractive surgery

- 1991- Ioannis Pallikaris- Greek Ophthalmologist- First laser assisted in situ keratomileusis
History of Laser Treatments

- Argon Fluoride- Argon and Fluorine gas react to make an excited dimer molecule (excimer) and radiate energy at 193 nm. Ar-F laser was invented in 1976.

- Most wide spread use is to make computer chips. Mercury Xenon was used in 1960s-1980s.

- 1981, IBM researcher Rangaswamy Srinivasan brought his Thanksgiving leftovers to the lab and irradiated turkey cartilage with the Argon-Fluoride laser. Noted precise control and no damage to adjacent tissue.

- 1983, Srinivasan worked with Stephen Trokel to demonstrate the precise effects on cows’ eyes.
History of laser treatments

- Charles Munnerlyn created the first working excimer laser for vision correction in 1985
- Created Munnerlyn’s formula
  - Ablation depth = Ablation diameter squared/3= microns per diopter ablated
  - Example- 6 mm optical zone is 12 microns ablated per diopter of treatment
  - Does not account for transition zones and astigmatism
History of laser treatments

- Types of lasers
  - Broad beam
  - Flying spot
  - Scanning Slit
AMO - VISX
Alcon- Wavelight Allegretto
History of laser treatments

- Evolution of laser treatments
  - Zone sizes
  - Transition Zones
  - Wavefront treatments
  - Aberrations
    - Correct Lower order - sphere, cylinder - up to 95% aberrations treated
    - Correct Lower and Higher order - coma, spherical aberration - up to 99% of aberrations
- Types of treatments
  - Wavefront-guided
  - Wavefront-optimized
- Topography-guided treatments
Hartmann-Shack Wavefront Sensor
Zernike Polynomials

<table>
<thead>
<tr>
<th>Common names</th>
<th>( Z_n^f )</th>
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<tbody>
<tr>
<td>Piston</td>
<td>0</td>
</tr>
<tr>
<td>Tip, Tilt (Prism)</td>
<td>1</td>
</tr>
<tr>
<td>Astigmatism, Defocus</td>
<td>2</td>
</tr>
<tr>
<td>Coma, Trefoil</td>
<td>3</td>
</tr>
<tr>
<td>Higher order</td>
<td>4</td>
</tr>
<tr>
<td>Spherical</td>
<td>5</td>
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</tbody>
</table>

\( n = \text{Radial Order} \)
History of LASIK Flaps

- Microkeratomes
  - Variable depth
  - Fixed depth
  - Hinge location
    - Nasal hinge
    - Superior hinge

- Femtosecond lasers
History of surface ablation techniques

- Photorefractive keratectomy (PRK)
- Advanced surface ablation
  - PRK with mitomycin C
  - LASEK
  - Epi-LASIK
PRK vs. LASEK
Epi-LASIK
Pre-operative assessment for laser vision correction

- Randleman’s criteria for keratoectasia risk
  - Age
  - Topography
  - Pachymetry
  - Residual stromal bed
  - Prescription
Ectasia risk factor score system

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Topography pattern</td>
<td>FFKC</td>
</tr>
<tr>
<td>RSB thickness (μm)</td>
<td>&lt;240</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>18–21</td>
</tr>
<tr>
<td>CT (μm)</td>
<td>&lt;450</td>
</tr>
<tr>
<td>MRSE (D)</td>
<td>&gt;–14</td>
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</table>

Via this method, any potential refractive surgery candidate could be given a cumulative score for ectasia risk. Based on that score, patients could be assigned a risk category, and surgeons advised whether or not to proceed with refractive surgery in the following way (courtesy of Ophthalmology).

<table>
<thead>
<tr>
<th>Cumulative Risk Scale Score</th>
<th>Risk Category</th>
<th>Recommendations</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 2</td>
<td>Low risk</td>
<td>Proceed with LASIK or surface ablation</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Moderate risk</td>
<td>Proceed with caution, consider special informed consent; safety of surface ablation has not been established</td>
<td>Consider MRSE stability, degree of astigmatism, between-eye topographic asymmetry, and family history</td>
</tr>
<tr>
<td>4 or more</td>
<td>High risk</td>
<td>Do not perform LASIK; safety of surface ablation has not been established</td>
<td></td>
</tr>
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</table>
Pre-operative assessment for laser vision correction

- Systemic diseases - Diabetes Mellitus, Autoimmune diseases.
- Ocular diseases - Keratoconus, Cataract, Uncontrolled glaucoma, Herpes Simplex Keratitis, Significant dry eye
- Medications - Accutane, Amiodarone, Imitrex
- Spectacle Prescription - Sweet Spot -8 D to +3 D, with less than 3 D of cylinder
  - Treatment Range - Approved from -14 D to +6 D, up to 6 D of cylinder
  - Stability of prescription, change in sphere or cylinder of less than 0.5 D in the past 12 months
Pre-operative assessment for laser vision correction

- Monovision option
- Dominant eye
- Pupil size
Surgical results - Custom LVC

- Myopia - 90% 20/20
- Hyperopia - 60% 20/20
Post-operative management

- LASIK
  - Flap evaluation
  - Medications- topical, oral

- PRK/ Advanced surface ablation
  - Epithelial defect
  - Haze evaluation
  - Medications- topical, oral
Post-operative management

- Dry eye
  - Regeneration of corneal nerves
- Treatments
  - Aqueous tear treatments
    - Artificial tears
    - Punctal plugs
    - Cyclosporine
    - Humidifier
    - Fan/ventilation modifications
  - Sunglasses
  - Goggles
Post-operative management

- Meibomian gland treatments
  - Warm compresses
  - Eyelid hygiene
  - Medications
    - Topical - Azasite, Tobradex
    - Oral - Doxycycline
Post-operative management

- Visual fluctuation
- Post-operative appointments