Management of Myopia in Adolescent

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Kerato-Refractive Procedures

- Remove tissue
  - Slice and Dice
  - Flap and Zap
- Modify tissue
  - CKR/Orthokeratology
Non Invasive Kerato-Refractive Procedures

CKR/Modern Orthokeratology
Pharmacology
Vision Therapy

Historical Development

• Corneal Reformation
  – Chinese (1360 - 1644)
  – Japanese
Historical Development

- Corneal Reformation
  - Patent Eye Cups (1850)
    - Dr. J. Ball & Co.

- Dr. J. Stephens & Co.
  - Cornea Restorer (1865)

“Spectacles rendered useless.”

- Kalt (1888) – Used blown glass scleral lenses in an attempt “to flatten the corneal apex in keratoconus”
**Historical Development**

- **Myopia Control**
  - Newton K. Wesley (NERF, 1955)
  - First National Contact Lens Congress (1955)
  - First World Contact Lens Congress (1959)

**Early Orthokeratology**

- **Fitting Methods**
  - Jessen (1964): “Orthofocus”
  - Nolan (1971): adjustable wearing time
  - Grant & May (1971): reduce lens mass
  - El Hage (1978): photokeratoscopy
  - Tabb (1980): compression
  - Wlodyga & Bryla (1989): reverse geometry
Corneal elevation is the measurement of height between two different points at different elevations.

Slope or Gradient is commonly used to describe the measurement of the steepness, incline or grade of a straight line from 2 points with different elevations.

Curvature is the rate of change of the slope. It is the second derivative of elevation and is calculated from the slope. The topographer calculates the curvature and elevation from the slope.
Corneal Topography

Sagittal or Tangential?

Tangential and Sagittal Radius

Both Centers on Axis for Vertex

Aspheric Surface (Tangential Section)

Sagittal Center

Sagittal Section

Vertex

Tangential Center

Eccentricity BOZR

<table>
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<th>Eccentricity</th>
<th>BOZR</th>
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<td>0.80</td>
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<td>0.60</td>
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Lens Designs for Corneal Reshaping

- Controlled Kerato-Reformation (CKR)
- CRT®
- BE Design
- Contex E System
- DreamLens
- Emerald Design
- NightForm
- R&R Design
- NightMove
- Vipok
- Fargo Design
- OrthoFocus
- Wave System
- Reversible Corneal Therapy
- Free Dimension / e Lens
- Alignment Series / Falcon

Common Fitting Characteristics

- 10-11.5mm OAD; 6.0mm OZD
- Desire good centration; limited lens lag
- Fit to achieve +0.50 - +1.00 D endpoint
Under-estimation of Corneal Sag
Zero or negative clearance – Smiley Face

Current Fitting Techniques
K's & Rx
Topography / Software
Inventory

Topography Based Designs
Optivision CornealMap EH-300
Topography Based Empirical CKR
University of Houston Study
Methods

- 25 subjects, 18-37 years of age
  - Myopia between 1.00 D. and 4.00 D.
  - Astigmatism no greater than 1.50 D.
  - Informed consent documents signed.
- Followed for six-months at 24-hours, 1-week, 2-weeks, 1-month, 3-months, and 6-months.

Methods

- logMAR visual acuity, subjective refraction, and a questionnaire
- Corneal topography, Confocal microscopy, ultrasound corneal thickness, aberrometry, and slit-lamp biomicroscopy were used to assess changes occurring in the cornea.

Overnight CKR™ Results
**Conclusions**

- Changes in total and epithelial corneal thickness measurements supported other researches in some individual subjects, but are variable depending upon the method used.
- Is corneal thickness the answer?
### Corneal Thickness Summary

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<th>Increase</th>
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<td>Carkeet, et.al, 1995</td>
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<td>Iskeldi, et.al, 1996</td>
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<td>Swarbrick, et.al, 1998</td>
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<td>Chow E, 2002</td>
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<td>Wang J, et.al,</td>
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<td>El Hage, et.al, 2007</td>
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<td>Fukuda, et.al,</td>
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<td>Jurkus, J, 2009</td>
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### How does CKR works?

- Intraocular pressure (IOP) acting on the cornea results in an elongation of corneal collagen fibrils due to their tensile-loaded capacity.
- CKR lenses/mold impose an external pressure upon the cornea counteracting IOP, which reduces the overall pressure upon the cornea.
- A pressure force of about 2mm Hg by the CKR Mold flatten the cornea by 0.5 mm. (A. Berke).

### CXL & CKR Same Time
Patient MA

- Rx: OD: -4.25 DSph.
  OS: -5.25 DSph.
- K's: OD: 45.00@160 /46.00@070
  OS: 45.50@010 /45.87@100

Controlled KeratoReformation (CKR™)

CKR™ Lens Design
Diagnostic Lens fitting
Selecting the appropriate lens
  - Flat K-reading
  - Aimed Myopia Reduction (AMR)
    - Refractive error plus -0.50 D

- AMR = -4.00
- Boston EQL II Yellow
  BC = 8.33    CT = 0.21
  Pwr = +0.50  Dia = 10.6
**Patient MA Night 1 F/U**

- **Baseline Rx**
  - OD: -4.25 DSph
  - OS: -5.25 DSph

- **Post 9 hrs wear Rx**
  - OD: -1.50 DSph
  - OS: -2.50 DSph

- **UCVA:**
  - OD: 20/100
  - OS: 20/200
  - OU: 20/80
**Patient MA Night 4 F/U**

- **Baseline Rx**
  - OD: -4.25 DSph
  - OS: -5.25 DSph
- **Post 6 hrs wear Rx**
  - OD: -0.25 DSph
  - OS: -0.25 DSph
- **UCVA:**
  - OD: 20/20
  - OS: 20/20
  - OU: 20/20

**Patient MA Night 18 F/U**

- **Baseline Rx**
  - OD: -4.25 DSph
  - OS: -5.25 DSph
- **Post 6 hrs wear Rx**
  - OD: +0.25 DSph
  - OS: -0.25 -0.50X180
- **UCVA:**
  - OD: 20/20
  - OS: 20/20
  - OU: 20/20

**Corneal Refractive Therapy (CKR™)**

<table>
<thead>
<tr>
<th>CKR™ Follow-Up Patient MA</th>
<th>Baseline</th>
<th>4 Nights</th>
<th>2.5 Weeks</th>
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<td>-0.25 DSph, UCVA: 20/20</td>
<td>+0.25 DSph, UCVA: 20/20</td>
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<tr>
<td>OS</td>
<td>-5.25 DSph</td>
<td>-0.25 DSph, UCVA: 20/20</td>
<td>+0.25-0.50X180, UCVA: 20/20-2</td>
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Astigmatism

Central

Limbus-to-Limbus

• Should not exceed 1.00 D difference between points at 4 mm temporal and 3.7 mm inferior.
Over Responders

Over Responder

• Decrease wearing time
• Reduce targeted myopia reduction
  – If original targeted reduction was -3.00 D, revise to -2.50 D or 2.00 D

Under Responders

Under Responder

• Increase wearing time
• Increase targeted myopia reduction
  – If original targeted reduction was 2.50 D, revise to 3.00 D

Reduced Holding Time

Reduced holding time

• Check for
  – Centration
  – Appropriate alignment within the anchorage zone
  – Excessive lens movement
    • Increase OAD
  – Rule out an under-responder
  – Lens protein or deposit build-up
Corneal Staining

Superficial Punctate Staining (SPS)
• Note that some early morning SPS is expected
• Rule out dry eye
• Staining may also be seen with poor tear exchange
  – Check for areas of excess bearing
  – Flatten or steepen the appropriate zone

Can CKR/OrthoK Stop Myopia Progression?

• TWO THEORIES:
  • The force that OrthoK lens put on the cornea causes the eye to grow more equatorially than axially
  • Optical signals peripheral to the macula may be responsible for regulating eye growth in primates. Light focused at the macula by OrthoK lens could provide clear vision while light rays focused through the mid-peripheral area of steepening in the cornea focus anterior to the retina

Refractive development is guided by optical defocus. Optically imposed refractive errors produce predictable refractive-error changes.

Positive Treatment Lens

Negative Treatment Lens

Imposed Myopia: To compensate, the eye must become more hyperopic.

Imposed Hyperopia: To compensate, the eye must become more myopic.
How should we correct progressing myopes?

Traditional Correction  Anti-Myopia Correction

The goal is to provide optimal central vision and to increase curvature of field to eliminate the peripheral stimulus for axial growth and/or produce visual signals that reduce growth.

THANK YOU

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