Management of Myopia in Adolescent

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Non Invasive Kerato-Refractive Procedures

CKR/Modern Orthokeratology
Pharmacology
Vision Therapy

Early Orthokeratology

• Fitting Methods
  – Jessen (1964): “Orthofocus”
  – Nolan (1971): adjustable wearing time
  – Grant & May (1971): reduce lens mass
  – Tabb (1980): compression
  – Włodyga & Bryla (1989): reverse geometry
MEASUREMENTS

- **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 Shape**

- **Oblate**
- **Prolate**

**Corneal Topography**

- **Sagittal**
- **or**
- **Tangential?**
Aspheric Surface

Tangential and Sagittal Radius

Both Centers on Axis for Vertex

Sagittal Center

Sagittal Section

Vertex

Tangential Center

Eccentricity    BOZR

<table>
<thead>
<tr>
<th>Eccentricity</th>
<th>BOZR</th>
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<tbody>
<tr>
<td>0.80</td>
<td>8.45</td>
</tr>
<tr>
<td>0.70</td>
<td>8.40</td>
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<tr>
<td>0.60</td>
<td>8.35</td>
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<tr>
<td>0.50</td>
<td>8.30</td>
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<td>0.40</td>
<td>8.25</td>
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<td>0.30</td>
<td>8.20</td>
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<tr>
<td>0.20</td>
<td>8.15</td>
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<tr>
<td>0.10</td>
<td>8.10</td>
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<tr>
<td>0.00</td>
<td>8.10</td>
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Corneal Reshaping & Orthokeratology
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

Fitting Technique

- Base Curve OZ 6.0 mm
- Reverse Curve 1.00 mm wide
- Alignment / Fitting Curve #1 0.5 mm wide
- Alignment / Fitting Curve #2 0.5 mm wide
- Peripheral Curve 0.3 mm wide

Anchorage Curve
Anchorage Curve

Correct Estimation of Corneal Sag
Ideal tear clearance – Bulls-Eye

Over-estimation of Corneal Sag
Excessive clearance – Central Island
Under-estimation of Corneal Sag
Zero or negative clearance – Smiley Face

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

CKR™ Design
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.

**Myopia Reduction**

<table>
<thead>
<tr>
<th>Wearing Time</th>
<th>Spherical Refraction (D)</th>
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<tbody>
<tr>
<td>9</td>
<td>-0.03</td>
</tr>
<tr>
<td>24-Hrs</td>
<td>-0.65</td>
</tr>
<tr>
<td>1-MO</td>
<td>-0.95</td>
</tr>
<tr>
<td>2-MO</td>
<td>-1.03</td>
</tr>
<tr>
<td>3-MO</td>
<td>-1.03</td>
</tr>
<tr>
<td>4-MO</td>
<td>-1.03</td>
</tr>
<tr>
<td>5-MO</td>
<td>-1.07</td>
</tr>
<tr>
<td>6-MO</td>
<td>-0.87</td>
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Spherical Refraction (D)
**Central Epithelial Thickness**

![Graph showing corneal thickness changes over wearing time.]

**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**

<table>
<thead>
<tr>
<th>Author</th>
<th>Increase</th>
<th>Decrease</th>
<th>No Change</th>
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<tr>
<td>Carkeet, et al, 1995</td>
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<td>Ipekci, et al, 1996</td>
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<td>Swarbrick, et al, 1998</td>
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<td>Lu Fan, et al, 1999</td>
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<td>Nichols, et al, 2000</td>
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<td>Mitsu, et al, 2002</td>
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<td>Chow E, 2002</td>
<td></td>
<td></td>
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<tr>
<td>Wang J, et al,</td>
<td></td>
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<tr>
<td>El Hage, et al, 2007</td>
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<tr>
<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).

**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
**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

**Controlled Kerato Reformation (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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<tbody>
<tr>
<td>OD</td>
<td>-4.25 DSph</td>
<td>-0.25 DSph</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</td>
<td>+0.25-0.50X180, UCVA: 20/20-2</td>
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Astigmatism

- 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 Responder

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
Management of Myopia in adolescent

THANK YOU

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