Orthokeratology

Ronald Watanabe, OD, FAAO
Associate Professor of Optometry
The New England College of Optometry
watanaber@neco.edu
Orthokeratology

• Programmed alteration of the corneal topography to create predictable change in refractive error to improve uncorrected visual acuity

• Use of reverse geometry rigid gas permeable contact lenses to reshape the corneal surface

• Usually done as an overnight procedure with no lens wear during waking hours
What is orthokeratology indicated for the correction of?

A. Myopia
B. Hyperopia
C. Presbyopia
D. All of the above
Orthokeratology Indications

• Myopia
  • FDA approval: Paragon CRT up to -6.00, B+L VST up to -5.00

• Astigmatism
  • FDA approval: Paragon CRT up to -1.75, B+L VST up to -1.50

• Hyperopia
  • Off-label, lower amounts of correction

• Presbyopia
  • Off-label

• Myopia control
  • For children who are progressive myopes
  • No age restrictions for OK treatment
Myopic Orthokeratatology

- The vast majority of OK is performed for myopia
- Recently, children are the primary population being fitted for OK due to its apparent myopia control effects

Efficacy
- Effective for reducing moderate myopia and low astigmatism
  - Decreasing efficacy with higher refractive errors
  - Claims by some manufacturers of up to -10 D of correction
- Induced aberrations
  - Spherical aberration for all, coma if treatment is decentered
- Seems to retard the progression of myopia vs conventional correction
  - Less increase in axial length ~45%: Li JPediatrOphthalmolStrabismus 2017
Efficacy of OK for Myopia Control

- Walline et al. Corneal reshaping and myopia progression. BJO 2009. Axial length 0.16 mm less per year over 2 yrs in OK group.
- Kakita et al. Influence of overnight orthokeratology on axial elongation in childhood myopia. IOVS 2011. Axial length 0.15 mm less in OK group over 2 yrs.
- Cho & Cheung. ROMIO. IOVS 2012. Axial length 0.27 mm less in OK group over 2 yrs. Faster progression in younger subjects.
- Downie & Lowe. CRIMPS. Eye Contact Lens 2013. 64% of OK eyes had total arrest of myopia.
- Wen et al. Efficacy and acceptability of orthokeratology for slowing myopic progression in children: A systematic review and meta-analysis. J Ophthalmol 2015. Axial length 0.25 mm less with OK. Pooled myopia control of 55% to 41% over 2 yrs.
Peripheral Refraction With and Without Contact Lens Correction

OVS 2010

Jie Shen*, Christopher A. Clark†, P. Sarita Soni§, and Larry N. Thibos$"
Various contact lens designs appear to create relative peripheral myopia that may help reduce myopia progression.

Orthokeratology creates altered corneal shape with central flattening and mid-peripheral steepening.

Center-distance multifocal lenses correct distance centrally and provide a ring of plus power mid-peripherally.
Ortho-K Mechanism of Action - Theory

• Create a post-lens tear layer with thickness differential that results in areas of positive and negative pressure on the cornea that cause flattening and steepening in desired areas

• For myopia: thin central tear layer that flattens the central cornea, thicker para-central tear layer that steepens the area around the flat central zone
Corneal Changes: Short-term

- Compression of epithelial cells where cornea flattened
- Swelling of epithelial cells where cornea steepened
- No changes to stromal thickness

From Choo et al, CLAE 2/08
Corneal Changes: Long-term

- Decrease in number of epithelial cell layers where compressed
- Increase in number of epithelial cell layers where expanded
- Corneal remodeling / Cell migration?

At 14 days
Corneal topography changes

- **Myopia**: central flattening, para-central ring of steepening, mid-peripheral flattening
- **Hyperopia**: central steepening with gradual flattening towards mid-periphery
- **Presbyopia**: small central zone of steepening surrounded by a small zone of flattening, para-central ring of steepening, mid-peripheral flattening
Which of the following structural changes does not happen with OK treatment?

A. Reduction in epithelial cell layers centrally
B. Meibomian gland distortion
C. Reduction in sub-basal nerve plexus density
D. Reduction in endothelial cell density
Safety of Orthokeratology Treatment

• OK treatment induces structural changes
  • Cornea:
    • Epithelial thinning / thickening: Choo CLAE 2008
    • Reduction in number of epithelial cell layers in treatment zone
    • Some stromal changes: thickening mid-peripherally
    • No endothelial cell changes: Cheung CLAE 2017
    • Sub-basal nerve plexus density was reduced and not recovered after discontinuation of treatment: Nombela-Palomo ECL 2017
Safety of Orthokeratology Treatment

• OK treatment induces structural changes
  • Conjunctiva:
    • Papillary hypertrophy, Meibomian gland distortion: Na ECL 2016
  • Tear film:
    • Increase in osmolarity: Nieto-Bona ECL 2016
    • Increase in OSDI: Na ECL 2016
  • Choroid:
    • Thickening of sub-foveal choroid: Li CLAE 2017
OK lenses and ocular infection

- Watt & Swarbrick (ECL 2007): 123 cases of microbial keratitis reported in the literature
- Peak number of cases in 2001, most in East Asia, OK was unregulated in China in 2001
- Most Acanthamoeba cases were in this year, tap water was often used as lens solution
- Significant decrease in cases of MK after 2001
OK lenses and ocular infection

• Choo (OVS 2009): OK lenses retain more Pseudomonas than alignment fitting GP lenses
  • Lenses were inoculated with Pseudomonas before being inserted in cat eye
  • Lenses were worn up to 6 weeks, 16 hours each night
OK lenses and ocular infection

- VanMeter (Ophthalmol 2008)
- Retrospective study of 75 peer-reviewed articles published in English
- No studies had Level I evidence
- 2 PMAs (B+L VST, Paragon CRT) and 2 studies had Level II evidence
- The rest were case reports that had Level III evidence
- Corneal staining: higher than other modalities, more with higher myopia and lens adhesion
- Iron deposits: non-significant, related to duration of treatment
- Prominent fibrillary white lines: nerve fivers in the sub-basilar plexus
- Endothelium: no effect
- Impossible to determine the risk of complications due to non-standard reporting and lack of randomized clinical trial

Level I = well-designed and well-conducted Randomized Clinical Trial
Level II = well-designed case-control and cohort studies, poor-quality randomized studies
Level III = case series, case reports, poor-quality case-control and cohort studies
OK lenses and ocular infection

- Bullimore (OVS 2013)
- Retrospective survey of 86 practitioners
- Submit information on any unscheduled visits for painful red eyes
- Patients had to have at least 3 months of OK lens wear
- 2599 patient-years of lens wear
- 8 corneal infiltrative events
- 2 cases of microbial keratitis (both in children, no loss of vision)
- Overall estimated incidence of MK = 7.7 per 10,000 patient-years of lens wear
  - Children: 13.9 per 10,000 patient-years
- Risk of MK is similar to that of other overnight CL modalities
Safety of Orthokeratology Treatment

- Liu & Xie (ECL 2016): Compiled results from literature review
  - Microbial keratitis: similar risk to other overnight CL modalities
  - Corneal staining: higher than other modalities, more with higher myopia and lens adhesion
  - Iron deposits: non-significant, related to duration of treatment
  - Prominent fibrillary white lines: nerve fibers in the sub-basilar plexus
  - Endothelium: no effect
  - IOP / corneal hysteresis: decreases in first week, return to baseline at 1 month
- Concluded that OK is a relatively safe option for myopia correction
Bottom Line regarding Safety of OK

- Appropriate patient selection
  - No pre-existing ocular health issues that may increase risk of complications
  - Patients / parents have to acknowledge and assume the risks noted above prior to starting treatment
- Proper fitting
  - No central adhesion, no peripheral seal-off/tightness
- Proper lens care
  - Cleaning and disinfection
  - Solution choice for lens insertion
- Early detection of problems
  - Patient to return immediately if has new symptoms
  - Regular follow-ups to detect subtle ocular problems, at least q6mos
  - Lens design changes or discontinuation if needed
Certification

- All FDA approved OK lenses require that practitioners be certified in the use of their designs
- Online certification
  - Review of OK theory
  - Review of OK fitting principles
  - Review of the design being used
  - Multiple choice test
Orthokeratology Fitting

• Indications & Candidacy
• Baseline data
• Lens design
• Follow-up
• Parameter changes
• Complication management
Indications

• Myopia
  • FDA approval
    • Paragon CRT: -6.00 D
    • B+L VST: -5.00 D
  • Off-label use up to -10.00 D

• Astigmatism
  • FDA approval
    • Paragon CRT: -1.75 D
    • B+L VST: -1.50 D

• Hyperopia
  • No FDA approval, more difficult treatment, up to +3.00 D possible

• Presbyopia
  • No FDA approval, more difficult treatment

• No FDA age restrictions
Who are good candidates?

- Motivated / Appropriate expectations
- Refractive error falls within FDA approval
  - Lower refractive errors are more easily corrected
  - Less astigmatism: average correction is ~1/2 of baseline corneal astigmatism
- Progressive myopes
- Good ocular surface health
- Anyone who wants to be free of spectacles and contact lenses during the day
- Laser surgery candidates who decide not to have surgery
- Athletes
- Dry eye patients?
- Soft contact lens failures?
Who are NOT good candidates?

• Higher refractive errors
• Astigmatism more than myopia
• Hyperopic astigmats
• Against-the-rule astigmats
• Internal astigmatism
• Large pupils
• Poor ocular surface health
  • Corneal staining / irregularity / inflammation
  • Dry eye / MGD / blepharitis
• Unreasonable expectations / non-compliant
Baseline Data

• Uncorrected visual acuity
• HVID
• Pupil size
• Keratometry
• Corneal topography
• Subjective refraction
• Biomicroscopy
  • Ocular surface health
  • Tear evaluation with fluorescein
How many FDA-approved ortho-K designs are there?

A. 2
B. 5
C. 12
D. They are all FDA-approved
Lens Design

- Reverse geometry
- 4 zones
  - Central base curve
  - Reverse curve
  - Alignment landing zone
  - Peripheral curve
- Large diameter
  - For better centration and stability
How the Lens Fits the Cornea

**Base Curve:** flatter than the central cornea, very thin tear layer (<10um)

**Reverse Curve:** steeper than the cornea to bring the back surface back to the cornea, thick tear layer

**Alignment curve:** similar curvature to mid-peripheral cornea to optimize centration

**Compressive positive pressure centrally**

**Mild compression**

**Negative pressure mid-peripherally**
Designing the OK Lens: Base Curve

- Determines amount of central corneal curvature flattening
- Flatter than central curvature by amount of refractive error you are trying to correct
- Additional flattening factor by 0.50 to 1.00 D to allow for regression throughout the day
- Example: K-reading = 44.00 DS
  - Refraction = -3.00 DS
  - BC is 3.50 D flatter than K = 40.50 D
- OZD is generally about 6.0 mm
  - May be smaller when trying to correct higher refractive errors
  - May be larger for patients with large pupils, but will reduce effect
Designing the OK Lens: Reverse Curve

• Because BC is very flat compared to the cornea, the edge of the OZ will be far away from the corneal surface
• To create lens centration and stability, the mid-periphery of the lens must be in alignment with the cornea
• The RC is steeper than the BC and brings the lens back to the corneal surface
• RC is 0.6 to 1.0 mm wide
• Also called Fitting Curve or Return Zone
Designing the OK Lens: Alignment Curve

- Designed to align with or be slightly steeper than the mid-peripheral cornea
- Provides stability and centration
- Provides mild compression to maximize para-central steepening
- Usually comprised of two curves in 4-zone designs
- In the Paragon CRT design, this zone is flat and is designed to be tangent to the cornea: Landing Zone
Examples of OK Designs

• Paragon CRT: K’s and SR: table / slide rule to select lens
• Dreamlens: K’s, SR, e-value, HVID: online design program
• Emerald: K’s, SR, HVID: call consultant
• BE Retainer: Corneal topography and SR: topography based design program
• WAVE: Corneal topography and SR: topography based design program
Approved Bausch + Lomb Vision Shaping Treatment (VST) Designs

Approved VST designs built for fitting flexibility:

- BE Retainer
- CKR
- Contex OK E-System
- DreamLens
- Emerald
- NightMove
- MiracLens
- Orthofocus
- Super Bridge and E-Lens Overnight Orthokeratology Lens
- Vipok Inc.
- WAVE NightLens
Paragon CRT lens selection chart

<table>
<thead>
<tr>
<th>Flat K</th>
<th>-0.25</th>
<th>-0.50</th>
<th>-0.75</th>
<th>-1.00</th>
<th>-1.25</th>
<th>-1.50</th>
<th>-1.75</th>
<th>-2.00</th>
<th>-2.25</th>
<th>-2.50</th>
<th>-2.75</th>
<th>-3.00</th>
<th>-3.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.00</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-525-33</td>
<td>82-500-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.12</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-525-33</td>
<td>82-500-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.25</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-525-33</td>
<td>82-500-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.37</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-500-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.50</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-500-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.62</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-500-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.75</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-525-33</td>
<td>81-525-33</td>
<td>82-500-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>43.87</td>
<td>78-525-33</td>
<td>79-525-33</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-500-33</td>
<td>81-525-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>44.00</td>
<td>78-525-33</td>
<td>79-525-33</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-500-33</td>
<td>81-525-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>44.12</td>
<td>78-525-33</td>
<td>79-525-33</td>
<td>79-525-33</td>
<td>80-525-33</td>
<td>80-500-33</td>
<td>81-525-33</td>
<td>82-525-33</td>
<td>83-525-33</td>
<td>84-525-33</td>
<td>84-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
<td>85-525-33</td>
</tr>
<tr>
<td>44.25</td>
<td>78-525-34</td>
<td>79-525-34</td>
<td>79-525-34</td>
<td>80-525-34</td>
<td>80-500-34</td>
<td>81-525-34</td>
<td>82-525-34</td>
<td>83-525-34</td>
<td>84-525-34</td>
<td>84-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
</tr>
<tr>
<td>44.37</td>
<td>77-525-34</td>
<td>78-525-34</td>
<td>78-525-34</td>
<td>79-525-34</td>
<td>80-525-34</td>
<td>81-525-34</td>
<td>82-525-34</td>
<td>83-525-34</td>
<td>84-525-34</td>
<td>84-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
</tr>
<tr>
<td>44.50</td>
<td>77-525-34</td>
<td>78-525-34</td>
<td>78-525-34</td>
<td>79-525-34</td>
<td>80-525-34</td>
<td>81-525-34</td>
<td>82-525-34</td>
<td>83-525-34</td>
<td>84-525-34</td>
<td>84-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
</tr>
<tr>
<td>44.62</td>
<td>77-525-34</td>
<td>78-525-34</td>
<td>78-525-34</td>
<td>79-525-34</td>
<td>80-525-34</td>
<td>81-525-34</td>
<td>82-525-34</td>
<td>83-525-34</td>
<td>84-525-34</td>
<td>84-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
</tr>
<tr>
<td>44.75</td>
<td>77-525-34</td>
<td>78-525-34</td>
<td>78-525-34</td>
<td>79-525-34</td>
<td>80-525-34</td>
<td>81-525-34</td>
<td>82-525-34</td>
<td>83-525-34</td>
<td>84-525-34</td>
<td>84-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
</tr>
<tr>
<td>44.87</td>
<td>76-525-34</td>
<td>77-525-34</td>
<td>77-525-34</td>
<td>78-525-34</td>
<td>79-525-34</td>
<td>80-525-34</td>
<td>81-525-34</td>
<td>82-525-34</td>
<td>83-525-34</td>
<td>84-525-34</td>
<td>84-525-34</td>
<td>85-525-34</td>
<td>85-525-34</td>
</tr>
</tbody>
</table>

Example:
- Flat-K = 44.00 D
- Refraction = -2.00 -0.75 x 180
- Chart says: 82-525-33
- BC = 8.20 mm
- RZD = 525 um
- LZA = 33 degrees
WAVE topography based design program
Orthokeratology Lens Design

• Selecting a design
  • FDA approval
  • Designs are similar with small differences
  • Some are more aggressive and may correct higher refractive errors, but may create more mechanical problems
  • Parameter selection and change methods
  • Consulting teams
  • Based on experience and/or colleague recommendations

• Ordering
  • Phone consultants
  • Online programs
Initial Dispensing

• Lens insertion
  • Prepare the patient
  • May need viscous wetting solution to fill in reverse curve area without bubbles

• Visual acuity
  • Should be 20/20 or equal to BCVA

• Over-refraction
  • Should be plano ±0.25 D

• Fluorescein pattern
  • Central “touch” zone should be 4-5 mm in diameter
  • 1-2 mm wide ring of clearance under reverse curve
  • Alignment zone in mid-periphery with low to moderate peripheral clearance
  • Remember that lens will not necessarily position or have the same tear lens profile as when the patient is sleeping
What is the purpose of performing an over-refraction over the ortho-K lens?

A. To make sure the base curve is appropriate
B. To make sure the lens power is correct
C. To make sure the lens will touch centrally
D. To make sure the lens was made correctly
Initial Dispensing

• If lens vision and fit are acceptable, OK to dispense

• Insertion & removal training
  • Lubricant for insertion
    • Ortho-K drops: thin and thick
    • Multipurpose solution – has preservatives
    • Unpreserved artificial tears – low to high viscosity (off-label)

• Lens care instruction
  • Daily cleaner recommended
  • Disinfection: hydrogen peroxide or GP disinfecting system
  • Protein remover
  • Progent
Follow-up

• 1 Day
  • To assess centration of treatment
  • To assess corneal staining due to adhesion or chemical sensitivity

• 1-2 Weeks
  • To assess treatment efficacy
  • Can make changes if treatment is not acceptable

• 1-3 Months
  • To assess long-term efficacy and safety
  • Vision throughout the day, consistency from day to day
  • Corneal / conjunctival problems

• Every 6 months thereafter
  • Watch for effects of deposit build-up, lens damage, lens parameter changes
Follow-up Procedures

• Unaided visual acuity
• Subjective refraction
  • Auto-refraction often not accurate due to variable refraction from center to edge of pupil (aberrations)
• Corneal topography
• Biomicroscopy
  • Without and with fluorescein
• Lens quality (after 6 months)
• Axial length measurement (for myopia control)
Vision and Refraction

• Expect UCVA of 20/20
  • 20/25 may be acceptable
• Problems:
  • Under-correction
  • Aberrations
  • Decentration
  • Corneal distortion
  • Corneal staining
Under-Treatment

• Two Primary Reasons
  • Inaccurate Base Curve: too steep
  • Excessive Sagittal Depth

• What to do:
  • Perform an over-refraction
  • If OR is NOT within ± 0.50 D, most likely base curve inaccurate
    • Flatten base curve .10 for every 0.50 D
    • Ask about compliance/wearing time
  • If OR IS within ± 0.50 D, most likely excessive sagittal depth
    • Flatten reverse curve or alignment curve
Glare/Flare

• Small treatment zone
  • Improve treatment effect

• Spherical aberration
  • Pt education

• Decentered treatment
  • Improve centration: adjust reverse / alignment curves, increase diameter

• Large pupils
  • Pt education, increase optic zone – may decrease treatment effect
  • Nighttime spectacle Rx
Corneal Topography

- Only way to assess treatment centration and efficacy
- Used to guide parameter changes to improve treatment
When ortho-K treatment is decentered, which lens parameter should NEVER be changed to improve centration of treatment?

A. Base curve  
B. Reverse curve  
C. Alignment curve  
D. Lens diameter
Superior lens position

- Flat-fitting lens
  - WTR astigmatism induced
  - “Smiley Face” topography
  - Steepen fit to improve centration
    - Reverse or alignment curve
Inferior lens position

• Steep-fitting lens
  • WTR astigmatism induced
  • “Frowney Face” topography
  • Flatten fit to improve centration
    • Reverse or alignment curve
Central island

- Steep-fitting lens
  - Poor visual acuity
  - Large residual refractive error
  - Steep island within flat central zone
  - Decrease sagittal depth of lens
    - Reverse or alignment curve
Lateral lens position

- ATR cornea or eyelid effects
  - ATR astigmatism induced
  - Increase diameter to improve centration
Central Corneal Staining

• Will cause blurry vision and corneal distortion
• Lens adhesion
  • Use thicker wetting solution
• Improper lens removal
  • Loosen lens with lubricant and gentle digital movement prior to removal
• Sagittal depth is too shallow
  • Steepen reverse or alignment curve
• Deposited / scratched / aged lens
  • Deep clean or replace lens
Other Corneal Staining

• Peripheral staining
  • Tight alignment / peripheral curves
  • Lack of tear exchange

• Lens care
  • More generalized / diffuse staining
  • Preservative sensitivity – change to unpreserved products
  • Rinse disinfecting solution well with unpreserved saline prior to insertion

• Hypoxia due to extended wear
  • Use higher Dk material
  • Dk 90-100 most common, can refit to Menicon Z / Boston XO2 / Opt Extreme
Corneal Iron Ring

• Similar to Fleischer ring and Hudson-Stahli line
  • Presume mechanism to be similar to deposition noted after surgical refractive procedures (iron deposition in basal epithelium)
• In area of paracentral tear pooling
• Appears after 6-12 months of lens wear
• Benign, no effect on vision – no treatment needed
• Reversible
Microbial keratitis

- Pseudomonas
- Acanthamoeba
- Other bacteria
- Fungus
- Unknown
- Risk factors
  - Overnight wear
  - Aged / deposited lenses
  - Poor lens care & hygiene habits
  - Ignoring symptoms
  - Not keeping follow up appointments
Case Studies
Case LJ

- 25-yo male
- K: OD 43.1 / 44.3 @ 96
  OS 43.3 / 43.9 @ 110
- SR: OD -1.25 -0.50 x 10
  OS -1.50 sphere
- HVID 11.5 mm
- Pupils 6 mm in dark
- SLE: All structures clear and healthy OU
Case LJ

- Paragon CRT-100
- Based on nomogram, select initial CLs
  - OD: 8.20 / 500 / 33
  - OS: 8.20 / 525 / 33
- Fit assessment
  - OR: OD -0.50, 20/20
    OS plano, 20/20
Final order: OD 8.20 / 500 / 34
OS 8.20 / 550 / 34
First AM follow-up

Problems?
UCVA: OD 20/20-
   OS 20/20
SR: OD plano DS
   OS pl -0.25 x 60
Right Eye Topography
Left Eye Topography
Troubleshooting Case LJ

- Central staining = sag depth too small
- Frowney face = too steep???
- FP = too flat / not enough sag depth
- Reorder?
  - CRT 8.20 / 525 / 34
1 week follow-up

• UCVA: OD 20/15
• SR: OD pl -0.50 x 15

OS 20/15
OS +0.25 -0.75 x 25
Case JW

- 35 yo WM
- Sim-K: OD 43.7 / 44.8 @ 80
  OS 43.9 / 44.9 @ 77
- SR: OD -4.00 -0.50 x 165
  OS -3.25 -0.50 x 175
- HVID: 12.0 mm
- Pupils: 7 mm in dark
- SLE: all structures clear OU
Case JW
Initial lens order: DreamLens

<table>
<thead>
<tr>
<th></th>
<th>OD</th>
<th>OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC</td>
<td>8.570</td>
<td>8.440</td>
</tr>
<tr>
<td>CLP</td>
<td>+0.75</td>
<td>+0.75</td>
</tr>
<tr>
<td>Dia</td>
<td>10.6 / 6.0</td>
<td>10.6 / 6.0</td>
</tr>
<tr>
<td>PC1</td>
<td>6.72 / 0.60</td>
<td>6.81 / 0.60</td>
</tr>
<tr>
<td>PC2</td>
<td>7.64 / 0.70</td>
<td>7.67 / 0.70</td>
</tr>
<tr>
<td>PC3</td>
<td>7.82 / 0.60</td>
<td>7.85 / 0.60</td>
</tr>
<tr>
<td>PC4</td>
<td>11.00 / 0.40</td>
<td>11.00 / 0.40</td>
</tr>
<tr>
<td>CT</td>
<td>0.22</td>
<td>0.22</td>
</tr>
</tbody>
</table>
Case JW
Follow-up

Day 4:
• 10 hrs overnight wear, off 1.5 hrs
• VA good until 4 pm
• Unaided VA: 20/20 in each eye
• SR: OD +0.25 -0.75 x 070
  OS -0.25 0.25 x 180
• SLE: all structures clear OU

Day 11:
• CL off 10 hrs
• VA good all day
• Haze in periphery at night
• Unaided VA: 20/20, 20/20⁻¹
• SR: OD plano sphere
  OS pl -0.25 x 15
• SLE: all structures clear OU
Case JW: 2 month Follow-up

- VA blurrier, OD worse than OS
- Unaided VA: 20/25^{-2}, 20/20
- SR: OD pl -0.75 x 80
  OS +0.50 -1.00 x 110
- Tight alignment curve OU

- Lens position change
- Poor lens care: no rub/rinse
- Solution sensitivity: Boston Advance
- Change in lens wear habits: inserted 1-2 hours before going to sleep
Case JW: Flatten AC for both lenses

• 10 micron change (0.15 mm radius of curvature)
• 2 weeks later, improved VA: 20/20-, 20/25 but still slightly blurry
• SR: OD -0.25 -0.50 x 110
   OS +0.25 -0.50 x 105
• Eyelid edema in AM: solution sensitivity reaction?
• Change solution from Boston Advance to Unique pH
Case JW: 3 week Follow-up

- Much improved VA and comfort: 20/20 OU
- SR: OD +0.25 sph
  OS +0.50 -0.50 x 165
- SLE: all structures clear OU
Case CE

• 10-yo female
• New OK patient, 3 month follow-up visit
• No problems prior to this visit
• Baseline OD -3.00 -0.25 x 90, OS -3.25 DS
• Paragon CRT lenses
• UCVA OD 20/20-, OS 20/20
• Good treatment zones OU
• Unique pH for disinfection and insertion
• Presents with no complaints
Case CE

- Slit lamp exam: mild to moderate central punctate staining OS>OD
Case CE: DDX

• Dry eye
  • Baseline testing?
• Deposit build-up on lenses
  • Lens inspection
• Solution sensitivity
  • More generalized staining
• Sagittal depth too low
  • Fluorescein pattern?
• Abrupt lens removal
  • Lens sticking in the morning
Case CE

- Discuss proper lens removal in the morning
  - Instill rewetting drops
  - Gently nudge lenses using eyelids
  - If using DMV device, light pressure only
- Change to gentler solutions for insertion
  - MPS have preservatives for disinfection: Unique pH, Simplus
  - Consider hydrogen peroxide disinfection
  - Solution for rinsing and cushioning
    - Unpreserved saline
    - PF artificial tears (off label)
    - Ortho-K drops: thin or thick
- Better cleaning
  - Rub/rinse after removal, possibly with daily cleaner
  - Protein removers
  - Progent on a monthly basis
  - Annual lens replacement
- If no improvement, steepen reverse curve to increase central sagittal depth
Thank you!