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Fitting Large Diameter Lenses to Irregular Corneas

Loretta Szczotka-Flynn, OD, PhD

Room: Valencia 5

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• Vistakon: Research Grant/Research
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• VSP Global: Honorarium/Speaking
Fitting Large Diameter Lenses to Irregular Corneas

Loretta Szczotka-Flynn, OD, PhD

Room: Valencia 5

Course Description

• This course will discuss a variety of large diameter lenses suited to treat the irregular cornea. The following designs and fitting techniques will be covered: Intralimbal lenses, scleral and semi-scleral lenses, piggyback fitting, and hybrid lenses.

Learning Objectives

• Learn the various large diameter options
• Understand when to select a particular design
• Learn step by step fitting approach for intralimbal lenses
Specialty Lens Options for the Irregular Cornea

- Small diameter Corneal Lenses
- Large Diameter Corneal Lenses
- Soft Lenses
  - Piggyback
- Hybrid
- Semi-Scleral
- Scleral

Two Basic Fitting Philosophies

- Fit the corneal contour
- Mask the corneal contour

"Using a Systematic Approach when Fitting Keratoconus, Irregular and Post Surgical Corneas"

- Always fit within the limbus as a first option
- Use high or hyper Dk materials eg Boston XO2 or Menicon Z

Corneal Lens Fitting

- “Fit” the corneal contour
- Graft shape dictates RGP design
Waring’s 5 Post-PK shapes:

- Originally Classified on Axial Data
  - Prolate 31%
  - Oblate 31%
  - Mixed (Prolate & Oblate) 17.8%
  - Asymmetric 8.7%
  - Steep to Flat 13.5%

Lens Selection Based on Graft Contour

- Prolate Cornea
  - Can simulate normal aspheric topography
  - Central cornea has a steeper radius surrounded by concentric flattening
  - Traditional fitting techniques may be used
  - Exception and not the rule in the CL practice

PRACTICE PEARL #1:
Try KC designs

- Oblate Cornea
  - Flat Central Topography With Steep Periphery
  - Very Common, at least in one meridian
  - May have heavy central clearance to align with peripheral cornea
  - Here is where the specialty stuff comes in handy

PRACTICE PEARL #2:
Start with AXIAL maps to

- Mixed Astigmatism
  - By definition, relatively regular astigmatism encompasses entire graft

PRACTICE PEARL #3:
Bitoric lens needed, almost always
Lens Selection Based on Graft Contour

- **Graft Tilt**
  - Account for approx. 22% of post graft topography
  - One portion of graft steepens, topography 180 degrees away flattens

**PRACTICE PEARL #4:**
GP lens will center over the steepest portion of the graft

- **Nasal or temporal tilt:**
  - Often decentered lens position unavoidable, use large lens to avoid glare
  - Bitronics not indicated

Masking the Corneal Contour

**Large Diameter Corneal Lenses**

- **Rose K2 IC**
  - 11.2mm diameter (Available 9.4mm – 12.6mm)
  - Posterior Aspheric Aberration Control Optics

- **Dyna Intralimbal**
  - 11.2 – 12.0 Diameter, 11.2mm standard
  - Spherical Posterior Optics

- **TITAN**
  - 11.3mm – 12.3mm Diameter
  - 11.0mm Standard Diameter
  - Spherical Posterior Optics

- **FTP**
  - 11.4mm – 11.4mm Diameter
  - Spherical Posterior Optics

- **K-Max**
  - 11.5, 12.0, 12.5 Diameter
  - Spherical Posterior Optics

- **Limbal**
  - 11.8mm Standard Diameter
  - Spherical Posterior Optics

- **G.B.L.**
  - 11.2mm Standard Diameter
  - Spherical Posterior Optics
Identifying cone type using a topographer
(difficult without a topographer)

Indications - When to use ??

- Pellucid Marginal degeneration - PMD
- Keratoglobus
- Lasik induced ectasia
- Post graft

EXAMPLE: POST PK FOR KC

What to look for in a fitting set
- Comprehensive BC range 6.0 to 8.6
- Some designs automatically account for the likelihood of oblate shape in flatter corneas and incorporate reverse geometries in flatter bases
  - Eg Rose KC Increased reverse geometry as BC flattens
- Large optic zone (may be aspheric) – vaults graft or irregular zone
- OZ decreases as BC steepens
For keratometers:
Choose first trial lens 0.3 mm flatter than the steepest corneal meridian
Assess in order:
1. central fit and any heavy corneal contact areas
2. peripheral fit, particularly noting tight and loose areas
3. diameter – should sit approx. 1mm inside the limbus
4. location
5. movement

Examples:

1. Central fit
   - Flat
   - Steep

2. Peripheral fit
   - Very tight periphery (std steep EL)
   - Ideal periphery (std flat)
   - Tight periphery (standard EL)

EDGE LIFT (peripheral fit)
Peripheral fit is **Singularly** the most important fitting factor for a successful comfortable fit.
"Using a Systematic Approach when Fitting Keratoconus, Irregular and Post Surgical Corneas"

What to look for in a fitting set:
IS THE AEL SET FOR EACH INDIVIDUAL BASE CURVE AND DIAMETER?
Lift factor effects every SC outside the OZ

**EXAMPLE OF LIFTS**
- Standard 65%
- Increased 20%
- Decreased 10%
- Other lifts 5 to 10%

"Using a Systematic Approach when Fitting Keratoconus, Irregular and Post Surgical Corneas"

How labs specify edge lift values

**Quadrant Specific Design Options**

Inferior Quadrant Control

- Available from a few laboratories
- Manufacturing procedure that steepens one or more quadrants
  - Typically only need the inferior quadrant only steepened
- Creates a more personalized fit
- Provides a more comfortable and stable lens
- Improves Visual Acuity

Example of quadrant specific steepening which allows the steepening of the inferior quadrant only
Quadrant Specific Design Options

Asymmetric Corneal Technology

Inferior Quadrant Control

Excessive lift corrected with inferior quadrant control

Examples using asymmetric corneal technology

- Some labs allow 3 standard grades
- Some labs have option to specify degree of tuck in steps by mm (0.4 to 1.5mm) or μ

Grade 1 (0.7mm steeper)
Grade 2 (1.0mm steeper)
Grade 3 (1.3mm steeper)

"Using a Systematic Approach when Fitting Keratoconus, Irregular and Post Surgical Corneas"

Use Asymmetric Corneal Technology

Blanchard
ACT grade 1 (0.7mm)
ACT grade 2 (1.0mm)
ACT grade 3 (1.3mm)

ROSE K2 IC ACT GRADE 2

Lens Dynamics
Steepen/flatten 15 steps in either direction
1 step steep 30 μ
1 step flat 50 μ

"Using a Systematic Approach when Fitting Keratoconus, Irregular and Post Surgical Corneas"

ACT - Improved comfort, lens stability and vision

NO ACT
WITH ACT
3. **Diameter** - intra limbal (approx. 0.5mm inside limbus)
   
   - Use minimum OD to achieve centration and comfort

4. **Location** - Tend to locate over steepest point on cornea
   
   - Remedies:
     - Steepen BC
     - Increase diameter
     - Correct edge lift
     - Consider piggybacking

5. **Movement**
   
   - Must move sufficiently to achieve tear exchange!

   **Excessive movement**
   - Increase diameter
   - Steepen BC
   - Reduce the edge lift (steeper)

   **Insufficient movement**
   - Decrease diameter
   - Flatten BC
   - Increase edge lift

---

**Using a Systematic Approach when Fitting Keratoconus, Irregular and Post Surgical Corneas**

**Scleral Lenses**
Scleral lens designs
Semi-scleral, corneo-scleral

- Jupiter Lens
  - Essilor
  - 15.6 mm diameter
  - 18.2 mm diameter
  - Posterior surface:
    - Consider reverse geometry
      - 2D or
      - 4D reverse

- SoClear (aka Macrolens)
  - Dakota Sciences
  - Diameter: 9.0-15.0 mm
  - BC: 5.82-9.00 mm

INTACS
(thanks to Buddy Russell)
Semi-scleral lens designs

- MSD Lens
  - Blanchard Labs
  - 36 lens trial lens set
  - Sagittal depth
  - Limbal clearance
  - 15.8 mm OAD
  - Custom curves
    - available

Case Examples

- One-Fit Cone
  - Blanchard Labs

Case Examples:

BC 0.5-1D flat

Ideal BC
Case Report- One Fit KC

Dre Claudine Courrey OD
Dr Langis Michaud OD MSc FAAO (Dipl)

Special testing

- Topo maps

One Fit (Blanchard Labs)

- Base curve selected with fitting guide
  - 0.2 mm flatter than Flat K
- Every 0.1 mm in BC change = 30 um = 0.50D
- Optimal goal: to get 150 um central clearance
Overall fit

Limbal coverage

Clinical findings at delivery

Optimal clearance 148 um

OCT assessment

A perfect landing

No conjunctival compression
No edge standoff
The best thing to come along for the post-keratoplasty patient:
THE SOFT LENS!!!

Contact Lens Selection
SOFT LENSES
PK/DALK
• Bandage lens indications
  – persistent epithelial defects
  – epithelial filaments
  – extreme height discrepancies at graft-host junction
• Bandage lens selection
  – Silicone hydrogels!!

Low Dk SOFT LENSES for post transplant
• Residual ametropia correction
  – Discouraged due to potential NV and graft rejection
  – NV removes immuno-privileged status of graft

Silicone Hydrogel Lenses
• Spheres
  – Doubtful unless used as piggyback
• Torics
  • Any Silicone Hydrogel Stock Toric
  • Definitive Silicone Hydrogel Custom
    – Material by Contamac
    » Lenses machined by Xcel, Art Optical, plus others
### Material Properties of Silicone Hydrogel Lenses

Currently Available in the United States

<table>
<thead>
<tr>
<th>Lens</th>
<th>Material</th>
<th>Dk**</th>
<th>Modulus (Mpa)</th>
<th>Water Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Optix Night &amp; Day</td>
<td>Aqualotrafilcon A</td>
<td>241.41</td>
<td>40</td>
<td>74</td>
</tr>
<tr>
<td>Aqualotrafilcon A</td>
<td>etafilcon A</td>
<td>480.75</td>
<td>32</td>
<td>74</td>
</tr>
<tr>
<td>Biofinity comfilcon A</td>
<td>331.21</td>
<td>40</td>
<td>47</td>
<td></td>
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<tr>
<td>Air Optix Aqualotrafilcon B</td>
<td>380.72</td>
<td>103</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acuvue Oasys comfilcon A</td>
<td>460.51</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avaira comfilcon A</td>
<td>361.19</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PureVision and</td>
<td>PureVision Custom</td>
<td>321.18</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>PureVision 2</td>
<td>470.43</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O2 Optix Custom</td>
<td>480.71</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PureVision and</td>
<td>PureVision 2</td>
<td>480.71</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Acuvue Advance and</td>
<td>Advance Plak</td>
<td>480.71</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Advance Plus</td>
<td>740.35</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definitive</td>
<td>480.71</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-Day Acuvue TruEye</td>
<td>740.35</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Modulus (Mpa) = Dk X10-11 (cm²/sec)[mlO2/mlXmmHg) 

**Dk**

Comparison: etafilcon A has a water content of 58%, Dk 21, and MPa 0.3

### Piggyback Lens Systems

#### Advantages
- Comfort
- Freedom from mechanical trauma

#### Disadvantages
- Two lens per eye daily management
- Optics?
- Coatings

#### Piggyback lenses

**PRACTICE PEARL:**
Steep BC needed for some oblate grafts

---

### O2 Optix Custom Sphere Parameters

<table>
<thead>
<tr>
<th>Material: etafilcon A</th>
<th>Water content: 32%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling tint: Light green</td>
<td>Modulus: 1.1 Mpa</td>
</tr>
<tr>
<td>Wearing schedule: Daily wear</td>
<td>Replacement schedule: Quarterly</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>Center thickness: 0.07mm</td>
</tr>
<tr>
<td>Available base curves (mm)</td>
<td>Sphere powers(D)</td>
</tr>
<tr>
<td>13.0</td>
<td>+20.00 to -20.00</td>
</tr>
<tr>
<td>14.0</td>
<td>0.25 steps</td>
</tr>
<tr>
<td>14.5</td>
<td>0.5 steps</td>
</tr>
<tr>
<td>14.8</td>
<td>0.75 steps</td>
</tr>
</tbody>
</table>

**PRACTICE PEARL:**
Steep base curves often needed for piggybacks
Predicted Tear Oxygen Tensions

PRACTICE PEARL
Watch oxygen delivery in some combinations


Tear Oxygen Tension beneath piggyback lens systems

<table>
<thead>
<tr>
<th>RGP Dk/t</th>
<th>SCL Dk/t</th>
<th>Open eye pO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>110</td>
</tr>
<tr>
<td>30</td>
<td>60</td>
<td>120</td>
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<td>40</td>
<td>80</td>
<td>130</td>
</tr>
<tr>
<td>50</td>
<td>100</td>
<td>140</td>
</tr>
</tbody>
</table>

Dk/t with low Dk and Silicone Hydrogels

Eye Specific Lens Material Interactions

Menicon Z, BXO, HDS 100 and all SH lenses OD resolves temporarily with Plasma Treated lenses

Menicon Z and Oasys OS
**PRACTICE PEARL**

Use soft lens to reshape the corneal contour

Topo over +7.00 Oasys

**PRACTICE PEARL:**

Piggyback soft lens can act as a prosthetic device

---

Hybrid Lenses

- SynergEyes
SynergEyes® Family

- SynergEyes® A
- SynergEyes® M
- SynergEyes® KC
- SynergEyes® PS

SynergEyes™ A High Dk Hybrid

- Material
  - Paragon HDS 100® GP Center (Dk 145)
  - 27% Water Non-Ionic Skirt (Group I)
- Design
  - 14.5 mm overall diameter
  - 8.4 mm rigid center
  - 7.8 mm optic zone

SynergEyes™ Fitting

Lens Movement
- .2mm to .3mm movement with blink
- Slight lag in upward gaze
- Free of scleral impingement
- Free to move on “push up”
- Free of “edge fluting”

Fluorescein Evaluation

- Apply lens
- Instill high molecule fluorescein
- Observe fluorescein pattern after 20-30 seconds of normal blink
### Fitting management

If edge fluting is observed, select steeper skirt radius.

<table>
<thead>
<tr>
<th>Fluting Picture</th>
<th>Fitting management</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP Center Base Curve</td>
<td>Power Management</td>
</tr>
<tr>
<td>7.1 (47.50)</td>
<td>8.40</td>
</tr>
<tr>
<td>7.2 (46.87)</td>
<td>8.50</td>
</tr>
<tr>
<td>7.3 (46.25)</td>
<td>8.60</td>
</tr>
<tr>
<td>7.4 (45.62)</td>
<td>8.70</td>
</tr>
<tr>
<td>7.5 (45.00)</td>
<td>8.80</td>
</tr>
<tr>
<td>7.6 (44.37)</td>
<td>8.90</td>
</tr>
<tr>
<td>7.7 (43.87)</td>
<td>9.00</td>
</tr>
<tr>
<td>7.8 (43.25)</td>
<td>9.10</td>
</tr>
<tr>
<td>7.9 (42.75)</td>
<td>9.20</td>
</tr>
<tr>
<td>8.0 (42.25)</td>
<td>9.30</td>
</tr>
<tr>
<td>8.1 (41.62)</td>
<td>9.40</td>
</tr>
<tr>
<td>8.2 (41.12)</td>
<td>9.50</td>
</tr>
</tbody>
</table>

### SynergEyes® PS Product Description

- **Paragon HDS 100® Rigid Center**
- **150 Dk (Revised Fit)**
- **Non Ionic 30% water Hydrogel Skirt**

### SynergEyes® PS Diagnostic Set Parameters

<table>
<thead>
<tr>
<th>Base Curve</th>
<th>Power</th>
<th>Steep Skirt</th>
<th>Medium Skirt</th>
<th>Flat Skirt</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5mm (45.00)</td>
<td>Plano</td>
<td>8.0</td>
<td>8.3</td>
<td>8.6</td>
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<td>7.8mm (43.25)</td>
<td>Plano</td>
<td>8.0</td>
<td>8.3</td>
<td>8.6</td>
</tr>
<tr>
<td>8.1mm (41.75)</td>
<td>Plano</td>
<td>8.3</td>
<td>8.6</td>
<td>8.9</td>
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<tr>
<td>8.4mm (40.30)</td>
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<td>8.6</td>
<td>8.9</td>
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<tr>
<td>8.7mm (38.75)</td>
<td>Plano</td>
<td>8.6</td>
<td>8.9</td>
<td>9.2</td>
</tr>
<tr>
<td>9.0mm (37.00)</td>
<td>Plano</td>
<td>8.6</td>
<td>8.9</td>
<td>9.2</td>
</tr>
<tr>
<td>9.3mm (36.37)</td>
<td>Plano</td>
<td>8.9</td>
<td>9.2</td>
<td>9.5</td>
</tr>
<tr>
<td>9.6mm (35.25)</td>
<td>Plano</td>
<td>8.9</td>
<td>9.2</td>
<td>9.5</td>
</tr>
</tbody>
</table>

### SynergEyes PS design

- **Oblate return curve starts on GP at 6.5mm and extends to soft at 9mm chord**

**PRACTICE PEARL #11:** Return curve can be varied: shallow, median or deep sag.
PRACTICE PEARL: realize a perfect fit cannot always be achieved!

THANK YOU