CONTACT LENS OPTIONS AND FITTING STRATEGIES FOR THE MANAGEMENT OF THE IRREGULAR CORNEA

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Consultant/Advisor/Speaker

- Accufocus
- Alcon
- AMO
- Annidis
- Bausch + Lomb
- Bruder Healthcare
- EyeBrain
- Optovue
- Revision Optics

Shire
Tear Lab
Tear Science
TLC Vision
Irregular Cornea
Contact Lens Options

- Standard Soft Lenses
- Custom Keratoconic Soft Lenses
- Corneal Gas Permeable Lenses
- Intra-Limbal Gas Permeable Lenses
- Piggyback and Recess Systems
- Scleral Gas Permeable Lenses
- Hybrid Lenses

Types of Irregular Corneas

- **Degenerations**
  - Keratoconus
  - Keratoglobus
  - Pellucid marginal degeneration
  - Temen’s marginal degeneration
  - Salzmann’s nodular degeneration
  - Ehlers-Danlos syndrome
- **After Surgery**
  - Cornea transplant (PK, PKP)
  - Radial keratotomy (RK)
  - Photorefractive keratectomy (PRK)
  - Phototherapeutic keratectomy (PTK)
  - Epikeratophakia
  - LASIK

- **Dystrophies**
  - Cogan’s dystrophy
  - Bowman’s dystrophy
  - Granular corneal dystrophy
  - Lattice corneal dystrophy
  - Meesmann’s corneal dystrophy

- **Corneal Scarring**
  - After infection
  - After trauma
CL Options: Soft Lenses

- **Advantages:**
  - Comfort
  - Centration (draping)
  - Corneal Protection

- **Limitations:**
  - Vision (due to draping effect)
  - Dehydration
  - Hypoxia /microbial contamination

CL Options: Custom Soft KC Lenses

- Hydrokone (Visionary Optics)
- NovaKone (Alden)
- Kerasoft (dist. By B&L)
- Soft K (Acculens & Advanced Vision, & SILC Labs)
- Continental Kone (Continental)
- Keratoconus lens (Gelflex)
- Soflex (Marietta)
- Ocu-Flex K (Ocu-Ease, Optech)
- UCL-55 (United)
- Flexlens Keratoconus (X-Cell)
- +++ Others
NovaKone
Breakthrough Design

What makes NovaKone work?

1. NovaKone uses lens thickness to neutralize corneal irregularity

2. The unique NovaKone optical design is then employed to correct for normal spherical and astigmatic refractive errors

3. Dual Elliptical Stabilization™ and precision Rx manufacturing ensure a stable precise Rx lens
Parameters

**NovaKone Rx Parameters**
See NovaKone Fitting Guide for specific lens guidance.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>Benz G4X 54%, Hioxificon D</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIAMETER</td>
<td>15.0 as standard, others available in 0.1 mm steps</td>
</tr>
<tr>
<td>BASE CURVE</td>
<td>5.4 and 5.8, 6.2, 6.6, 7.0, 7.4, 7.8, 8.2, 8.6 as standard, others available in 0.1mm steps</td>
</tr>
<tr>
<td>FITTING CURVE</td>
<td>8.2, 8.4, 8.6 as standard, others available in 0.1mm steps</td>
</tr>
<tr>
<td>SPHERE POWER</td>
<td>+30.00 to -30.00 in 0.25D steps</td>
</tr>
<tr>
<td>CYLINDER POWER</td>
<td>up to -10.00 in 0.25D steps</td>
</tr>
<tr>
<td>AXIS</td>
<td>1° to 180° in 1° steps</td>
</tr>
<tr>
<td>IT FACTOR*</td>
<td>0 = standard thickness</td>
</tr>
<tr>
<td>(increased thickness)</td>
<td>1, 2, 3, 4 incrementally thicker for higher levels of irregularity</td>
</tr>
</tbody>
</table>

*IT Factor is used to increase the lens thickness when irregularity is observed.

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**Step 1**
Select Initial Base Curve

<table>
<thead>
<tr>
<th>AVERAGE K</th>
<th>BASE CURVE</th>
<th>FITTING CURVE</th>
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<tbody>
<tr>
<td>41.00 to 42.99</td>
<td>8.6</td>
<td>8.6</td>
</tr>
<tr>
<td>43.00 to 46.99</td>
<td>8.2</td>
<td>8.6</td>
</tr>
<tr>
<td>47.00 to 49.99</td>
<td>7.8</td>
<td>8.4</td>
</tr>
<tr>
<td>50.00 to 52.99</td>
<td>7.4</td>
<td>8.4</td>
</tr>
<tr>
<td>53.00 to 55.99</td>
<td>7.0</td>
<td>8.2</td>
</tr>
<tr>
<td>56.00 to 58.99</td>
<td>6.6</td>
<td>8.2</td>
</tr>
<tr>
<td>59.00 to 61.99</td>
<td>6.2</td>
<td>8.2</td>
</tr>
<tr>
<td>62.00 to 64.99</td>
<td>5.8</td>
<td>7.8</td>
</tr>
<tr>
<td>65.00 to 67.99</td>
<td>5.4</td>
<td>7.8</td>
</tr>
</tbody>
</table>

*Average K for CENTRAL 3 to 4 mm ONLY*
Fit Evaluation
with high molecular weight fluorescein

Step 2
The IT Factor

- IT = “Index of Thickness”, ranges from 0 to 4.
- We recommend using the lowest IT factor possible.
- The more irregular the cornea, the higher the IT Factor should be to optimize visual acuity.
- Verify IT factor with Keratometry or Topography over the lens. If any irregularities are observed, increase the IT Factor to improve optical stability.
Mire Evaluation

Keratometric mires over the NovaKone lens will be crisp and clear with the proper IT factor.

Topography

Image courtesy of Karen Zar, OD, Talamo Laser Eye Consultants
Step 3
Determine Lens Power

- Over-refract and calculate the power of the Rx lens
- Compensate for Vertex distance if necessary
- Compensate for rotation
  - All Dx lenses have Dual Elliptical Stabilization to assess rotation
  - Dx lenses have no actual cylinder power

Step 4
The Fitting Curve

The fitting curve should demonstrate typical fitting characteristics of a standard soft lens fit.

- If the fitting curve is too flat there will be excessive movement and/or edge lift (order steeper fitting curve)
- Little or no movement and/or edge impingement would indicate the fit curve is too steep (order flatter fitting curve)
- Alden labels the fitting curve with the actual radius in millimeter, practitioners should be comfortable with these values in relationship to a “good” lens fit.
  - The fitting curve should be adjusted in a minimum of 0.2mm increments
Cl Options: Corneal GP Fitting Goals

- “Avoid Apical Bearing!”
- Match the periphery of the cornea (if normal)
- “Size Matters”: larger more decentered areas of irregularity require larger lenses & OZ
- Address Vision Needs: irregularity, astigmatism, presbyopia

Tandem/Piggyback Contact Lens Fitting In Irregular Comeas
CL Options: Tandem/ Piggyback CL

- Soft lens component contributes about 20% of its power in air to the system
  - Typically low power (+/- 0.50) – has negligible influence on GP fit or net system power
  - Use of + power to somewhat mask corneal irregularity and possibly improve GP centration – ie, use of apx. +6 (~ +1.2D Net effect)
- High DK material
- Can combine with any GP design

CL Options: New Hybrid CLs

- Combination GP center & Soft periphery
- Advantages:
  - Vision of GP / Comfort of SCL
  - One lens to handle
  - High Oxygen Transmission
  - Design Options
    (reg cornea, MFL, KCN, Rev. Geom)
CL Options: New Hybrid CLs

- **Historical Disadvantages:**
  - Lens tightening over time
  - Secondary inflammatory response
  - More difficult with larger and more decentered cones/irreg. C’s
  - Design limitations (fit & vision)

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**UltraHealth Lens Design**

- Reverse Geometry
- Aspheric Base Curve
- Variable Lift Zone
- Rigid Inner Landing Zone
- Soft Outer Landing Zone
### Lens Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Specifications</th>
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<tbody>
<tr>
<td>Vaults</td>
<td>50µ-550µ</td>
</tr>
<tr>
<td>Skirt Curves</td>
<td>7.9, 8.1, 8.4, 8.7</td>
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<tr>
<td>Diameter</td>
<td>14.5mm</td>
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<tr>
<td>Lens Powers</td>
<td>+10.00D to -20.00D</td>
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<tr>
<td>Dk</td>
<td>GP 130 SiHy Skirt 84</td>
</tr>
</tbody>
</table>

### Fitting Basics

- Evaluate fluorescein pattern
- Optic section with fluorescein
Ideal Diagnostic Lens

1. Apical clearance 100µ to 150µ above the corneal apex
2. Thin tear layer beneath the inner landing zone (ILZ)
3. Centered lens with ½ to 1mm movement with each blink

After 3-5 Minutes

1. Apical clearance decreases by approximately 50µ
2. Thin tear layer beneath the inner landing zone (ILZ)
3. Centered lens with ½ to 1mm movement with each blink
Vaulted Design and Corresponding Fluorescein Pattern

- Oblate corneas a challenge with limited options
  - Centration
  - Movement
  - Minimal vault for best optics
## Intro To Scleral Lenses

### Scleral Classifications: New Nomenclature

<table>
<thead>
<tr>
<th>Lens Type</th>
<th>Description</th>
<th>Definition of Bearing Area</th>
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<tbody>
<tr>
<td>Corneal</td>
<td></td>
<td>Lens Rests Entirely On Cornea</td>
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<tr>
<td>Corneo-Scleral</td>
<td></td>
<td>Lens Rests Partly on Cornea &amp; Partly on Sclera</td>
</tr>
<tr>
<td>Scleral</td>
<td>Mini-Scleral</td>
<td>Lens Rests Entirely on Sclera Up to 6mm &gt; HVID</td>
</tr>
<tr>
<td></td>
<td>Large Scleral</td>
<td>Lens Rests Entirely on Sclera More than 6 mm &gt; HVID</td>
</tr>
</tbody>
</table>

Adopted from Nomenclature introduced by Scleral Lens Education Society (June 2013).

### Lens Dk vs Clearance

<table>
<thead>
<tr>
<th>Lens Dk</th>
<th>Clearance 100 µm</th>
<th>Clearance 125 µm</th>
<th>Clearance 150 µm</th>
<th>Clearance 200 µm</th>
<th>Clearance 250 µm</th>
<th>Clearance 300 µm</th>
<th>Clearance 350 µm</th>
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<td>260</td>
<td>229</td>
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<td>300</td>
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<td>783</td>
<td>689</td>
<td>517</td>
<td>260</td>
<td>104</td>
<td>-50</td>
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</table>

Recommendations on Expected Clearance?
Intro To Scleral Lenses
Risk and Benefit Ratio

- Fitting complexity increases despite subjective comfort
  - I/R skills
  - Dk/t
  - Lens flexure
  - Conjunctival tissue modulus
  - Scleral Toricity
  - Scleral Obstacles
  - Wetting angle
  - Debris entrapment
  - Tear exchange
  - Limbal clearance

Intro Scleral Lenses
Potential Indications: A Growing List

Ocular Surface Protection & Therapeutic
- OSD (Sjogren's KCS, Dry eyes, SJS, OCP, GvHD, Chemical/thermal burns, Stem Cell failure, Neurotrophic keratitis, Delayed Epithelial Healing, Trichiasis, Entropion/Ectropion, Scleral-/Mucosa-Patch Grafts...)
- Pterygium/Pinguecula
- ?Off label - Drug delivery/retention?

Optical Rehabilitation
- KC/Ectasia
- PMD/Keratoglobus
- PKP and other post-surgical comeas (ie, RK)
- Scarring (ie, Post-trauma, corneal anesthesia)
- Corneal dystrophies
- Presbyopia*/Aphakia*/High Ametropia*

Cosmesis
- Scleral Prosthesis
- ?Painted Iris? Lid Ptosis Crutch?
**Scleral Lenses**

- Becoming extremely popular for all irregular corneal conditions
  - Great comfort
  - Remarkable acuity
  - Becoming easier to fit

Scleral market estimates Bausch & Lomb data and internal estimates

**Scleral Indications**

- Steep KC corneas
- Flat, post refractive surgery corneas
- The wide array of post graft cornea shapes
- Small corneas and large corneas
Initial Scleral Lens Fitting

- Normal ocular shape!
- Start near the middle of your lens set but error towards steeper/deeper lenses
- Keratometry and ocular sagittal depth can be helpful

Intro To Scleral Lenses
Basic Fitting Objectives
**Intro To Scleral Lenses**

**Where Do I Start?**

- Back Surface OZ
  - Central vault
  - Aspheric/Spheric
  - Toric/Multifocal
- Transition Zone
  - Limbal + scleral vault
  - Lens geometry
- Haptics/Landing Zone
  - Aligns with scleral toricity
    - Toric/Quadrant specific
    - Impression or Scleral Profiler
Intro To Scleral Lenses
Where Do I Start?

- SAG Depth = \( \frac{R - \sqrt{R^2 - (1 - SF) \times C^2}}{1 - SF} \)
- \( R \) = Apical radius (BC)
- \( SF \) = Shape factor/Q (PCs)
- \( C \) = HVID/2 (Diameter)

Prolate versus Oblate

This example shows the difference in base curve and shape of Zenlens prolate and oblate designs. Note both lenses have the same sag.

Oblate lens with 9.50 BC
Oblate shape will have from 250 to 400 um of additional mid-peripheral clearance compared to prolate shape.

Prolate lens with 7.80 BC
4900 SAG
Lens #3 (prolate) and Lens #15 (oblate)

Design Attribute

- Lens adjustments will not affect the rest of the lens fit
  - If fitter wants something changed, they just ask for the change and everything else remains consistent, e.g.:
    - Can change SAG without having to change base curve
    - Can increase limbal clearance without having to change the SAG
    - Can modify the shape of the lens without altering the SAG.
Attribute : The Smart Curve

Moving the fit points:
Design Attribute #4

- Generous scleral landing area

Design Attribute #5

- Toric PCs are available to order
  - Scleral landing curves are available in 30 micron steps—flatter or steeper
  - You can mix and match them to create the toricity you desire
- Front toric optics can be added to the anterior OZ
  - With back surface scleral zone toricity or with front surface dual elliptical stabilization for rotational stability
Evaluate the Corneal Clearance
Evaluate the Corneal Clearance

Dx lenses have CT of 350 microns.

If you want somewhere in between, just specify the sag you want.

Intro To Scleral Lenses
It All Starts in the Center!

- SAG estimation after “proper” settling (± NaFL)
  - Optic Section (~45°)
  - OCT
    - Design variables
    - Patient variables

**Intro To Scleral Lenses**

It All Starts in the Center: VRM

Can estimate in lens design:
1) Central clearance, &
2) BC-related SAG changes

BC 6.9mm = 359 µm

BC 7.6mm = 116 µm

Courtesy, Langis Michaud OD, MSc, FAAO
Evaluate the Limbal Clearance
Evaluate the Limbal Clearance

Insufficient Limbal Clearance:

Request additional microns of clearance added to standard:

+50 microns if limbal touch is within one quadrant

+100 microns if touch/bearing is in two quadrants

+150 if it's in three quadrants

If 360 degrees of touch, try larger diameter

Additional microns can be requested in any amount. Displayed values are suggestions.

Evaluate the Scleral Landing Zone
Scleral impingement

Blanching at 3 & 9 o’clock:
Ordered toric APS
Flat 2 / Stp 1

Toric APS
One Week Scleral Lens F/U

**Haptic Assessment**
- Impingement
- Mid-haptic compression
- Blanching

3.5 Hours
Settling
Time

**VA s c c**
OD: 20/20
OS: 20/20

**SC OR**
OD: 0.00 DS
OS: 0.00 DS
Search For Edge Lift

- Instill NaFl
- Wait a few minutes then reassess
- Is it worth changing things up?

Reassess

- Pump in NaFl
- Check for lens tightness by rotating
- Dye distributed!
Assessment Made Easy

OD: 2 CTAC / 360 LC / HA / mod debris
OS: 2 CTAC / 360 LC / HA / debris on F1

Keratoconus Challenge
CL Options: Scleral Haptic Evaluation

Edge too steep: compression

Courtesy:
Blanchard Latis
& Langis Michaud O.D., M.Sc. FAAO
Keratoconus Challenge
CL Options: Scleral Haptic Evaluation

Edge too steep: compression

Optimal landing

Courtesy: Blanchard Latte & Langis Michaud O.D., M.Sc. FAAO
Intro To Scleral Lenses
It All Starts in the Center!

- SAG estimation after “proper” settling (± NaFL)
  - Optic Section (~45°)
  - OCT
    - Design variables
    - Patient variables

Choosing the proper diameter

If lens is too small:
-- APS lands at limbus / Limbal clearance will not be achieved.
-- Patient discomfort; Limbal injection and/or staining.

If lens is too large:
-- Increased scleral toricity
-- More debris in tear film
-- Greater amount of decentration

Fitting the Zenlens

Over-Refract to determine final lens power:

- Adjust over-refraction for vertex distance
- Factor in -2.00 power of the Dx lens
- If modifying SAG value from the Dx lens, Base Curve can remain constant, so no need to adjust lens power for SAG
- If cylinder is present in over-refraction, use topography or keratometry to check for lens flexure
  - Refer to cylinder correction chart

Shadowing of the Lens Edge

- Position slit beam across lens and view the far lens edge
Shadowing of the Lens Edge

- Easy way to assess the edges for excessive lift.
- Position slit beam across lens and view the far lens edge.
Shadow at 3/9 O’Clock

Shadowing of Lens Edge - Oblique
Fitting the Zenlens
Patient AG

- AG: 45 year old Hispanic male
- History of keratoconus
- Had corneal transplant 2015 in OS
- Advanced keratoconus in OD - contact lens failure
- Having corneal transplant in OD next month
Four Step Lens Evaluation Process

- Evaluate Central Clearance
  - Adjust clearance in microns
  - Each lens in diagnostic set is 100 μm different

- Evaluate Mid-Peripheral Clearance
  - If central clearance is ideal, base curve adjustments can increase/narrow mid-Peripheral clearance and decrease excessive mid-Peripheral clearance

- Evaluate Limbal Clearance
  - Adjust clearance in microns
  - Lower clearances (without touching) aid in centration

- Evaluate Advanced Peripheral System landing on conjunctiva
  - Flatten or steepen APS in 30 μm steps
  - Toric peripheries are available
Final Result

- Visual acuity OS: 20/25 +2
- Able to wear lens full day with good comfort
- Anxious to have transplant on OD
Patient MP

- 64 year old WF
- History of Fuchs dystrophy
- Had PKP OD: 2006, OS 2014
- Wearing RGP’s for past 10 years
- Comfort has decreased and vision not stable
- Wearing time has decreased to 9 hours per day

Exam Findings

Contact lens fit:
Zen Lens
OD: 7.7 Base curve / 4650 sag / 16.0mm dia / Flat 3 edge / Plano
OS: 7.1 Base curve / 52.00 sag / 16.0 mm dia / Flat 3 edge / +0.50
Visual acuity with Scleral Contacts

OD: 20/20
OS: 20/20 -2

Wearing time 14 hours per day
Very comfortable
Patient comments on how clear her vision is

Patient OV

- 26 year old Hispanic male
- Referred to our office due to drastic vision change
- Seen by two other eye doctors who could not determine the problem with his eyes and could not provide glasses which worked
- Pentacam confirms diagnosis of keratoconus
Patient OV

- Slit Lamp shows mild thinning inferiorly OU
- Topography shows more aberration in visual axis OD
- Pentacam shows inferior posterior distortion
- Went over options for visual correction: Glasses, soft lenses, RGP's, Hybrids, Sclerals
Patient OV

- Patient decides to go with Scleral contacts
- Dispense Blanchard One Fit 2.0, a good design for early cones
- Final lenses:
  One Fit 2.0:  OD: 8.0 BC / 14.9 dia / -3.75 / std edge
  OS: 8.0 BC / 14.9 / -2.25 / Steep 1
Patient OV

- Visual acuity with contacts: OD 20/20, OS 20/15
- Wearing time 12-14 hours per day
- Patient very happy with crispness of vision as well as comfort