SCLERAL CONTACT LENS FITTING AND TROUBLESHOOTING

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OUTLINE

- Introduction
  - Brief Hx
  - Nomenclature
  - Advantages & Disadvantages
  - Indications & Contraindications

- Fitting
  - Initial Consultation
  - Fitting Methods
  - Insertion & Removal
  - Lens Assessment

- Troubleshooting
  - Complications

INTRODUCTION
**Brief History**

1. **1508 – da Vinci**
   - Enclosing reservoir of fluid over cornea
   - Concept of optical neutralization

2. **1888 - Fick**
   - First practical contact lenses
   - Scleral lenses made of blown glass shells

3. **1983 - Ezekiel**
   - First practical scleral lenses
   - Made of oxygen permeable material

4. **Today**
   - High Dk materials
   - Computer assisted manufacturing processes

- **Problems with first scleral contact lenses**
  - Hypoxia and manufacturing issues

- **Oxygen permeable scleral lenses**
  - Improved physiological ocular response but further development postponed with advancements in corneal GPs and soft (hydrogel) contact lenses

- **High Dk Materials**
  - Better comfort, longer wearing time, broader indications

- **Improved Manufacturing Technology**
  - More reproducible, more accurate, less expensive
  - More complex designs

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**Scleral Lens Design**

**Scleral Lens Zones**

- Scleral zone (Haptic/Edge)
- Limbal/Transition zone
- Corneal (optic) zone
- Limbal/Transition zone
- Scleral zone (Haptic/Edge)

*Note: Only back surface shown*
Scleral Lens Design

- Peripheral Curve
- Scleral zone (Haptic/Edge)
- Limbal/Transition zone
- Corneal (optic) zone

# Scleral Lens Nomenclature

<table>
<thead>
<tr>
<th>Classification</th>
<th>Size</th>
<th>Fitting Relationship With Cornea</th>
<th>Fitting Relationship With Sclera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corneo-scleral/corneo-limbal/limbal</td>
<td>12.9 – 13.5mm</td>
<td>Corneal bearing</td>
<td>Scleral touch</td>
</tr>
<tr>
<td>Semi-scleral</td>
<td>13.6 – 14.9mm</td>
<td>Corneal touch</td>
<td>Scleral bearing</td>
</tr>
<tr>
<td>Mini-scleral</td>
<td>15.0 – 18.0mm</td>
<td>Minimal corneal clearance</td>
<td>Scleral bearing</td>
</tr>
<tr>
<td>Full scleral</td>
<td>18.1 – 25.0mm</td>
<td>Maximal corneal clearance</td>
<td>Scleral bearing</td>
</tr>
</tbody>
</table>

- Based on average corneal diameter (12.8mm)$^{1,2}$

ADVANTAGES

- Corneal clearance
  - Optical neutralization
  - Corneal protection
    - Hydration
    - Decrease scarring
- Fitting of irregular corneas
- Comfort
  - No lid interaction with lens edge
  - Bearing of lens on sclera (less sensitive)
- Large optic zone
- Alternative to corneal surgery
- Relief of pain & photophobia, general increase in quality of life
DISADVANTAGES

- Decreased tear exchange
- Reduced oxygen availability to cornea
- Increased cost
- Insertion and removal challenges
- Size can be intimidating for patient
- Handling (?)
  - Scleral lens more fragile
  - Some patients find it easier
- Complicated fitting process (?)
- Increased time required for fitting
  - Time for lens to settle
  - More visits required to finalize fit

INDICATIONS

- Two main indications take advantage of the large tear reservoir created by corneal vaulting unique to scleral lenses

1. Vision Improvement for Irregular Corneas
   - Ectasia
   - Post-surgical
   - Scarring

2. Corneal Protection
   - Hydration
   - Protection from lids and lashes
   - Ocular surface diseases
   - Corneal dystrophies or degenerations
**Other Indications**

- Failure of other lens designs
  - Stability
  - Discomfort
  - ↓ VA
- High refractive error
- Vocational/avocational needs
  - Active lifestyle
  - Sports
    - Eg. Water sports
  - Dusty environment

CONTRAINDICATIONS

- Low endothelial cell count
  - Suggested minimum of 800 cells/mm²
  - Advanced stages of Fuch’s
- Corneal transplant where graft rejection is a concern
- Inflamed conjunctiva
- Lack of dexterity for insertion and removal

Scleral Lens Fitting
INITIAL CONSULTATION: CONSIDERATIONS

- Know indications and contraindications to identify good and poor candidates
- Know advantages and disadvantages to educate patient and ensure ScCL is right for them
- Set appropriate patient expectations
  - Do not promise outcomes before lens is applied
- Do not focus on size of lens or rigid material
  - Discuss the cooling and refreshing feeling instead
INITIAL CONSULTATION: ASSESSMENT

- Baseline topography and pachymetry
  - Helpful for monitoring ocular health
  - Depending on fitting method, may use this information for initial lens selection

- Extensive Hx of past and current Tx
  - Ensure any current Tx will not be affected or have an effect on ScCL wear
    - Eg. use of Rx eye drops

- Extensive SLE
  - Thoroughly detail and document
  - Photography if possible
Scleral Lens Fitting Methods

- Diagnostic Fitting with Preformed Lenses
  - Most common and recommended technique
- Empirical Fitting
  - Not feasible without scleral topography
- Impression Technique
  - Expensive
  - Specialized equipment
- Future Directions
  - Topography of anterior sclera
DIAGNOSTIC FITTING: INITIAL LENS SELECTION

- Choose general design
  - Oblate corneas – reverse geometry design
- Choose LD based on HVID
  - Generally ~16mm
- Sag selection:
  1. **Side profile**
     - 3 sizes or “go to” lenses for each lens diameter:
       - Small, medium and large sag
  2. **Fitting guide**
     - BOZR does not correlate well with K readings
  3. **OCT**
     - Use AS-OCT to determine sag of eye at a particular chord length related to the diameter of the ScCL
     - Case Example

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Relationship Between Corneal Topography and ScCL Base Curve

- Schornack & Patel (2010)
  - Jupiter scleral contact lens
  - No relationship

- Romero-Jimenez & Flores-Rodriguez (2012)
  - Rose K2 XL semi-scleral contact lens
  - Differences in central K readings and lens BOZR:
    - Smaller for patients with keratoconus and corneal ring segments
    - Larger for patients with PMD, keratoplasty, and post-LASIK ectasia
      - Central cornea flatter
      - Forced to fit steeper BOZR to increase sagittal depth
CASE EXAMPLE: SCCL FITTING WITH OCT

- KD is a 19 year old male with bilateral keratoconus. The right eye was stable with no symptoms. The left eye was more advanced and caused visual distortions.
- He had corneal cross-linking surgery with INTACS™ insertion performed in the left eye 4 months prior to being fit with contact lenses.
- His subjective Rx OS was: -0.50 -2.00x155 (6/18+)
- Slit lamp exam showed double segment INTACS™ and central corneal striae in the left eye, but otherwise no other concerns.
- Visante OCT™ (Zeiss Meditech, Germany) anterior segment imaging...
ANTERIOR SEGMENT OCT OF KD’S LEFT EYE

- The calipers show the sagittal depth of the eye at a 15.8mm chord.
CASE EXAMPLE

- Sagittal depth at 15.8mm chord = 4.24mm
- Added depth for vaulting = 0.25mm
- Added depth for settling = 0.10mm
- Calculated initial diagnostic lens: $4.24mm + 0.35mm = 4.59mm$

- Initial MSD™ 15.8mm diagnostic lens sag = 4.60mm
- Lens power: -2.50D (6/6-)
- Fit assessment:
  - Good centration
  - Complete corneal and limbal clearance
  - Scleral alignment
MSD™ lens with good corneal and limbal clearance on an eye with corneal cross-linking and double segment INTACS™
EFFICIENCY OF SCCL FITTING METHODS

- Gemoules (2008)
  - Used sag measurements from Visante OCT to determine sag of initial trial lens selected
  - Average of 1.7 attempts per patient
  - Used small # of patients (n=9) and not clear on exact method

# Efficiency of Scleral Lens Fitting

<table>
<thead>
<tr>
<th>Study</th>
<th>Lens Design</th>
<th>Subjects</th>
<th># Visits</th>
<th># Trial Lenses</th>
<th># Ordered Lenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schornack &amp; Patel (2010)</td>
<td>Jupiter</td>
<td>Keratoconus</td>
<td>2.8</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Pecego et al. (2012)</td>
<td>Jupiter</td>
<td>Various</td>
<td>6.2</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Romero-Jimenez &amp; Flores-Rodriguez (2013)</td>
<td>Rose K2 XL Semi-Scleral</td>
<td>Various</td>
<td>2.7 ± 0.73</td>
<td>2.9 ± 1.6</td>
<td>1.4 ± 0.56</td>
</tr>
</tbody>
</table>

EXAM ROUTINE

1. Insert lens

2. Immediate initial assessment
   - Blue penlight useful
   - Check for insertion bubbles
   - Gross fit evaluation
     - Central touch
     - Peripheral compression and toric patterns

3. Lens assessment after settling
   - Settling period can vary widely between patients and lens designs
   - Recently published: Most settling within 4 hours
   - Consider fitting one eye at a time
   - Wait at least 30 min, but allow room for more settling

EXAM ROUTINE CONTINUED...

4. Remove lens
   • Do this yourself to assess presence or absence of suction

5. Repeat as needed until final lens parameters determined
   • Follow fitting guide or speak to lab consultant to make appropriate lens modifications

6. Assess eye without lens
   • “Leave no mark behind”
     ◦ Philosophy at BFS according to Lynette Johns
   • Cornea: SPK, edema, neovascularization
   • Conjunctiva: hyperemia, staining, indentation
INSERTION

- Prepare lens
  - Clean and rub with GP solution to hydrate
  - Rinse thoroughly with preservative free (pf) saline
  - Place lens on plunger (or ring applicator or O-ring)
  - Fill bowl of lens with pf saline
  - Swirl Fl strip in solution

http://www.dmvcorp.com/gas_permeable_products.htm
INSERTION

- Prepare patient
  - Discuss process
  - Raise chair and place paper towel on patient’s lap
  - Patient leans forward, looking straight down with chin tucked in
  - Provide appropriate fixation target

SynergEyes UltraHealth Fitting Guide

http://www.dmvcorp.com/gas_permeable_products.htm
**Removal**

- Ease of removal can indicate suction
- Do not administer solution first
- Plunger is recommended
  - Reduce IOP spike
- Hold lids
- Place plunger on lower half of lens
- Remove by pulling lens away from eye and up
- Examine eye without lens on slit lamp
**Scleral Lens Assessment**

- Central corneal clearance
  - Ideally ~250µm
  - Use optic section or OCT

- Limbal clearance
  - Ideally at least 50µm
  - Use optic section or OCT

- Scleral landing zone
  - No compression/blanching or impingement

- Check for debris build up on front surface and in post-lens tear layer
Corneal Clearance

www.ferris.edu/ScleralLensFitScales
TROUBLESHOOTING AND COMPLICATIONS
**Scleral Lens Fitting Challenges**

- Romero-Jimenez & Flores-Rodriguez (2013)
  - Rose K2 XL semi-scleral

<table>
<thead>
<tr>
<th>Cause for reordered lenses</th>
<th># Lenses</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased edge lift</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Decreased edge lift</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Steeper BOZR</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Increased power</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

- **Edge lift**: Evaluation is a learning process, unavoidable
- **BOZR**: Could be avoided if lens was allowed longer settling time at fitting visit (eg. 2 hours)
Scleral Lens Fitting Challenges

Complications

- Segal et al. (2003)
  - Mild conjunctival hyperemia in 13 of 59 eyes
  - Resolved after 1 month (continued lens wear)

- Visser et al. (2007)
  - % of eyes with lens-related complication:
    - Bulbar conjunctival hyperemia: 20.8%
    - Corneal staining: 6.7%
    - Corneal edema: 6.7%
    - Palpebral signs: 6.3%
    - Limbal hyperemia: 2.1%
    - Corneal vascularization: 1.1%
Troubleshooting & Complications

Bubbles

- **Insertion**
  - Most common cause of bubbles
  - *Solutions:*
    - Re-educate on insertion technique
    - Do not overfill lens prior to insertion
    - Use more viscous pf solution for insertion

- **Haptic misalignment**
  - More common with larger lenses
  - *Solutions:*
    - Toric peripheral curves
    - Smaller lens diameter

Troubleshooting & Complications

Compression
- Pressure on conjunctival tissue
- Results in blanching
- Solutions:
  - Increase edge lift/flatten periphery
  - Steepen periphery and lift limbal zone

Impingement
- Pinching of conjunctival tissue
- Results in conjunctival staining
- Can lead to conjunctival hypertrophy
- Solution: Increase edge lift/flatten periphery
Troubleshooting & Complications

Suction
- Can cause difficulty with lens removal or edema
- **Solutions:**
  - Lubricate well and use upper lid to break suction
  - Flatten peripheral curves

Edge Lift
- Use Fl to identify
- Can cause discomfort (lens awareness), bubbles, and debris in chamber
- **Solutions:**
  - Toric haptic
  - Smaller lens design

TROUBLESHOOTING & COMPLICATIONS

Chamber Debris

- More likely to occur with haptic misalignment
- Look for tear exchange with Fl insertion with lens in place

*Solutions:*

- Toric haptic
- Decrease edge lift/steepeen periphery
- Eliminate preservatives in care system
- Use viscous solution with insertion

<table>
<thead>
<tr>
<th>Description</th>
<th>Association</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, fluffy</td>
<td>Mucous, GPC</td>
<td>Use pf care system</td>
</tr>
<tr>
<td>Cloudy</td>
<td>Atopy</td>
<td>Rx MCS or soft steroid</td>
</tr>
<tr>
<td>Lipid droplets</td>
<td>Poor lid hygiene</td>
<td>Educate patient on lid care</td>
</tr>
</tbody>
</table>
TROUBLESHOOTING & COMPLICATIONS

Front Surface Debris

- Inquire about hand soap, creams, make up, etc.

Solutions:
- Increase ocular lubrication
- Remove lens for cleaning midday
- Use cotton swab and saline to rub FS with lens in eye
- Address lid hygiene
- Send lens to lab for polishing
TROUBLESHOOTING & COMPLICATIONS

Inadequate Central Clearance
- Bearing on cornea may cause epithelial injury or lens adherence
- *Solution*: Increase ScCL sag (steepen BOZR)

Inadequate Limbal Clearance
- May cause limbal epithelial hypertrophy, SPK, and discomfort
- *Solutions*:
  - Increase lift in transition zone
  - Increase chamber size
Troubleshooting & Complications

Pinguecula
- Note location relative to limbus
- Solutions:
  - Avoid by fitting smaller LD
  - Rest haptic on top, use toric PC
  - Vault over

Loose Conjunctival Tissue
- Transient vs Permanent
- Solutions:
  - Do nothing (transient)
  - Surgical removal (permanent)
TROUBLESHOOTING & COMPLICATIONS

Hypoxia
- Can cause edema and neovascularization
- **Solutions:**
  - Decrease wear time
  - Increase tear exchange
  - Re-fit into smaller lens design

Solution Toxicity
- May cause decreased comfort, diffuse hyperemia, photophobia
- Can result from inappropriate solution used for insertion or failure to rinse inside of lens
- **Solution:**
  - Non-preserved saline or unit dose inhalation saline
TROUBLESHOOTING & COMPLICATIONS

Residual Astigmatism

- Determine with sphere-cyl over-refraction
- From lens flexure
  - Determine with over-keratometry
  - Solution: Increase centre thickness
- From internal astigmatism
  - Lenticular or abnormal posterior corneal shape (eg. INTACS)
  - Solutions:
    - Front toric design
    - Specs over ScCLs
FUTURE DIRECTIONS

- Fitting and assessment with OCT
  - Scleral topography
  - Sagittal depth measurements
- More indications for regular corneas
  - High ametropia
  - Presbyopes
- Increasing complexity of FS optics
  - Multifocal designs
  - Higher order aberrations
  - Custom wavefront corrections
  - Optic zone decentration
RESOURCES

- A Guide to Scleral Lens Fitting
  - Eef van der Worp
  - http://commons.pacificu.edu/mono/4/
- The GP Lens Institute (GPLI)
  - http://www.gpli.info/
- Scleral Lens Education Society
  - http://www.scleralens.org/
- Clinical Manual of Contact Lenses (4th ed.)
  - Edward S. Bennett, Vinita Allee Henry
- Scleral Lens Fit Assessment Guide
  - www.ferris.edu/ScleraLensFitScales
THANK YOU!