Spherical Soft Contact Lenses

Principles of Design and Fitting
Module 3, IACLE

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Soft Contact Lenses

- Primary lens type fitted
  - >80%
- Good initial comfort
- Simple to fit
- Ideal if no spectacle astigmatism
- Ideal if low Rx
SCL Wearing Modality

- DW (daily wear)
  - removed each night
  - cleaned & reinserted or thrown away
- FW (flexi wear)
  - occasionally slept in
- EW (extended wear)
  - slept in every night for up to 6 nights
- CW (continuous wear)
  - slept in for up to 30 nights
SCL Replacement Schedule

- **Conventional**
  - no planned replacement time
  - typically 6-18 months

- **Planned replacement**
  - lenses replaced on a regular basis
  - typically 2/52 - 6/12

- **Disposable**
  - replaced after every wear
  - typically 1-day DW or 7-30 day EW/CW
SCL Materials

- All lenses contain water
  - 24 - 85%
  - for conventional lenses $\uparrow WC = \uparrow O_2$ transmission
  - Reverse is true for silicone-hydrogel lenses $\downarrow WC = \uparrow O_2$

- Some lens materials are negatively charged
  - due to presence of methacrylic acid
Water Content

- Low ➞ 20 to 40%
- Medium ➞ 41 to 60%
- High ➞ > 61%
SCL Materials: FDA Classification

- Group I: Low H₂O, non-ionic
- Group II: High H₂O, non-ionic
- Group III: Low H₂O, ionic
- Group IV: High H₂O, ionic
## Summary

<table>
<thead>
<tr>
<th></th>
<th>Low $\text{H}_2\text{O}$</th>
<th>High $\text{H}_2\text{O}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Ionic</td>
<td>GROUP I</td>
<td>GROUP II</td>
</tr>
<tr>
<td>Ionic</td>
<td>GROUP III</td>
<td>GROUP IV</td>
</tr>
</tbody>
</table>
Soft Lens Fitting

Thickness Description

Spherical, Minus Lenses:

- $< 0.06 \text{ mm}$: ultra-thin
- $0.06 - 0.10 \text{ mm}$: thin
- $0.10 - 0.15 \text{ mm}$: standard
- $> 0.15 \text{ mm}$: thick (obsolete)

For a given series, positive & toric lenses have their $t_c$ (center thickness) governed by BVP (back vertex power) & lens design.
SCL Design

- Best oxygen performance would occur with thin HWC (high water content) lens
  - Not practical
    - too fragile
    - dehydrate too much
  - pervaporation
Water Content and Pervaporation

- **High Water Lenses**
  - lose more water (% of total) than low water on eye
  - water loss due to ↑ocular temp, pH and tonicity even in high humidity environment
  - experience on-eye lens shrinkage affecting TD (less) and **Base Curve BC** (steeper “tighter”) affecting lens fit
Lens Design Parameters
## Lens Design

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>&gt; HVID</td>
</tr>
<tr>
<td>Thickness</td>
<td>Overall profile, centre, midperiphery</td>
</tr>
<tr>
<td>Back Surface Curvature</td>
<td>Aspheric- variation across lens or spheric- usually bicurve, curvature in centre</td>
</tr>
<tr>
<td>Front Design</td>
<td>Lenticulated, FOZD, spherical or aspheric</td>
</tr>
</tbody>
</table>
## Lens Design - Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>12 to 15.5 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.035 to 0.35 mm</td>
</tr>
<tr>
<td>BVP</td>
<td>±35.00D</td>
</tr>
<tr>
<td>Back Surface Curvature</td>
<td>bicurve or aspheric</td>
</tr>
<tr>
<td>Front Design</td>
<td>bicurve or aspheric</td>
</tr>
</tbody>
</table>

**Aberration Control Lenses**
Ideal Fitting Requirements
Soft Lens Fitting

- Desired Fitting:
  - centred on eye
  - conform to anterior eye
  - move adequately with the blink
  - cover the cornea in all positions of gaze
Soft Lens Fitting

○ Performance requirements:
  ● produce good and stable vision
  ● provide minimal physiological response
  ● be wearable for practical periods of time
  ● be comfortable
Parameters Affecting Lens Fit
Parameters Affecting Fit

- Lens design
- Lens diameter
- Lens base curve
Same Sag, Same Diameter

but... Different Design = Different Behaviour
• Increasing sagittal depth tightens the fit
• Bigger lenses of same radius fit tighter
• Flatter lenses of same diameter fit looser
Effect of Radius on Fit

Variable Base Curves

Diameter

8.3 mm
8.6 mm
8.9 mm
Fitting Procedure
Prediction of Lens Parameters

- **Step 1**: measure HVID
- **Step 2**: select LD
- **Step 3**: select BC
- **Step 4**: vertex spec Rx to ocular plane
- **Step 5**: select trial lens
- **Step 6**: assess fitting characteristics
### Step 2: Lens Diameter (LD)

<table>
<thead>
<tr>
<th>HVID</th>
<th>LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10.0 mm</td>
<td>13.0 to 13.5 mm</td>
</tr>
<tr>
<td>10.5 to 11.5 mm</td>
<td>13.8 to 14.2 mm</td>
</tr>
<tr>
<td>&gt;11.5 mm</td>
<td>14.3 to 15.0 mm</td>
</tr>
</tbody>
</table>
## Step 3: Base Curve (BC)

<table>
<thead>
<tr>
<th>LD</th>
<th>BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.0 to 13.5 mm</td>
<td>0.6 mm flatter than flat K/average K</td>
</tr>
<tr>
<td>13.8 to 14.2 mm</td>
<td>0.8 to 1.0 mm flatter than flat K/average</td>
</tr>
<tr>
<td>14.3 to 15.0 mm</td>
<td>1.2 to 1.5 mm flatter than flat K/average</td>
</tr>
</tbody>
</table>

Drapes over cornea onto flatter sclera
Step 4: Back Vertex Power (BVP)

- take best sphere (low cyl amount)
- vertex back to cornea
- predict contact lens power
- select trial lens closest to predicted power
- sph/cyl over-refraction
- best sphere over-refraction, compare to prediction
BVP Examples

- 3.25 DS
  - Try -3.25 sphere

- 3.25 / -0.50 x 180
  - Try -3.25 OR -3.50

- 7.25 / -0.50 x 180
  - Try -6.75 OR -7.00

- 4.25 / -1.25 x 180
  - Needs soft toric
Step 5: Trial Lens Selection

- Extended Wear (EW) or Daily Wear (DW)
- ionic or non-ionic
- high or low water
- centre thickness
- disposable or PRP
- match both BC and power
- tints? handling?
Step 6: Assess Fitting

- Diameter
- Centration
- Position & movement on blink with eye in:
  - primary gaze
  - lateral gaze
  - up-gaze
- Lower lid push-up test in primary gaze
SCL Assessing Fit

1. SCL diameter
2. SCL centration
3. SCL movement
1. SCL Diameter

**Too large**
- inadequate lens movement
- impingement on limbal vessels, causing engorgement

**Too small**
- localised exposure causing dehydration staining
SCL Rule of Thumb:

- When you increase the TD by 0.5 mm you must flatten the BC by 0.3mm to maintain the same fitting characteristics.

- When you decrease the TD by 0.5mm you must steepen the BC by 0.3mm to maintain the same fitting characteristics.
2. SCL Centration

- Optical
- Comfort
- Physiological
  - corneal exposure
  - corneal desiccation
  - limbal trauma
  - conjunctival trauma
- About 1 mm symmetrical overlap is ideal
3. SCL Movement

- Lens type
- Lens design
- Physical properties of lens material
  - especially rigidity
- Fitting relationship
- Lid factors
- Anterior eye topography
Why Is Movement Required?

- **Movement:**
  - removes and disperses ocular debris
  - promotes tear exchange (minimal)
  - possibly aids in epithelial wetting by mucin spreading and smoothing
Effect Of Thickness On Lens Fit

- Thick lenses move more than thin
- On-eye behaviour not necessarily directly related to lens thickness
- Effect of lens profile/design on thickness is relevant
Soft Lens Fitting

- Observe lag on eye movement
  - primary gaze
    - (0.2 - 0.75 mm acceptable)
  - upgaze
    - (up to 1.5 mm acceptable)
  - lateral eye movements
    - (up to 1.5 mm acceptable)
Soft Lens Fitting
Effect Of A Blink

- **Too steep (tight)**
  - vision is clear and/or keratometry mires become clearer immediately after a blink

- **Too flat (loose)**
  - vision is blurred and/or keratometry mires become more blurred immediately after a blink
Soft Lens Fitting
Assessment of Tightness

- Movement in millimetres
- % Tightness
  - 100 % = bound
  - 40-60 % desired
  - 0% = lens won’t stay on eye
- Ease of lens push-up
Soft Lens Fitting
Tightness: What Is Acceptable?

- Post blink movement 0.25 to 0.75 mm
- Slightly less movement *may* be acceptable with higher Dk/tc lenses
Fitting Factors

- Optimal lens fit
Soft Lens Fitting
What Is Not Acceptable?

- Lens edge curling/wrinkling
  - too loose
- Conjunctival indentation
  - too tight
- Excessive decentration
  - exposure
- Excessive movement producing visual disturbances
Soft Lens Fitting

What Is Not Acceptable?

- No movement even if “push-up” test OK
- Corneal exposure under any circumstances
- Fits producing limbal or peri-limbal “scuffing”
- Fits which result in blink-related visual disturbances
Soft Lens Fitting
Excessive Tightness

○ Indications:
  ● Lens immobile even when lower lid push-up manipulation attempted
  ● Conjunctival indentation at lens edge
  ● Blood flow constriction in peri-limbal vessels under lens periphery
  ● Low grade inflammation
  ● Vision better immediately after a blink
Soft Lens Fitting
Excessive Looseness

Indications:

- If extreme, lens will not stay in eye
- Excessive lens movement
- Wrinkling/buckling of lens edge
- Vision variable but worse immediately after blink if decentred
  - if lens centred blink may make little or no difference
Indications:

- Inferior lens lag even in primary eye position
- Lens may slip off cornea in up-gaze and/or up-gaze blink
- Subjective discomfort due to lens mobility