The ABCs of Fitting Soft Contact Lenses

What is a Soft Contact Lens?

- Pliable material
- Large diameter
- Excellent memory
- Bulk manufacturing

Successful Soft Contact Lenses

- Top 3 considerations
  - Wettability
  - Mechanical properties
  - \(O_2\) permeability
- Other considerations
  - Manufacturing / Cost
  - Hydraulic & ionic permeability
  - Optical clarity
  - Deposit resistance
Contact Lens Chemistry

- Monomers = building blocks
- Polymers = multiple monomers
- Co-polymer = 2 different monomers polymerized together
- Macromer = large monomer (advantageous properties?)

PMMA

Contact Lens Chemistry

Polymers = “Clothes Line”
The Clothes = suspended chemical groups

Function of the clothes = bind water & / or increase O₂ permeability (Si-Hy)
Crosslinking = adds stability

Contact Lens Chemistry

Example:
Step 1. Add (2-hydroxyethyl methacrylate (HEMA))
Step 2. Polymerize
Step 3. Add water (hydration)
Result = Traditional contact lens material
Manufacture

- Spin cast
- Lathe cut
- Cast molding

Lathe Cutting

Soft Lens Vials
The “Cons”

• Filcon = Soft
  • Example: lotrafilcon A (Air Optix Night & Day)

• Focon = Rigid
  • Example: hexafocon A (Boston XO)

Advantages

• Initial comfort
• Large size
• Part-time wear
• Eye color changes

Advantages

• Ease of fit
• Low incidence of flare / glare
• Minimal spectacle blur
Disadvantages

• Physiology?
• Do not mask corneal astigmatism
• Optics
• VA
• Cost (long term)

Disadvantages

• Life expectancy
• Care
• Difficult to verify
• Greater risks

Indications

• Spherical refractive error
• Low astigmatism
• Part-time
• Contact sports
• Good tear layer
Indications

- Previous GP failure
- Extreme refractive errors
  - Minimal - less motivation
  - High - better centration
- Anisometropia

Contraindications

- Physiologically compromised eye
  - post surgical
  - ocular disease
  - systemic disease
- High astigmatism
- Irregular astigmatism

Contraindications

- Poor hygiene
- Atopic disease
- Vascularization
Categories

- Manufacture
- Water Content
- Chemistry
- DW vs. EW / FW
- Anterior surface optics

What is a Silicone Hydrogel?

Also referred to as a soft lenses
Similar diameters
Stiffer?
Greater oxygen permeability
Manufacturing

Daily Wear vs. Extended Wear

- Quantifying Oxygen Permeability
  - Dk
    - Oxygen Permeability
  - Dk/L (also Dk/t)
    - Oxygen transmission
    - (Dk/C.T.)/10
Silicone / Hydrogel Lenses

Dk vs Water

An increased Dk is linked with a decrease in water content

Replacement Schedule

- Daily
- 2 week
- 1 Month
- 3 Month / Quarterly
Disposable
• FDA Definition: replaced after each use (i.e. remove and discard)

• Replacement Frequencies
  – Daily
    • Examples: Acuvue 1•Day Moist, Dailies Aqua Comfort Plus, Biotrue ONEday, Clearsight 1 Day, Proclear 1 Day

Replacement Schedule
• 2 Week Replacement
  – Examples: Acuvue 2, Soflens 66, Acuvue Oasys, Avaira

Replacement Schedule
• 1 Month Replacement
  – Examples: Air Optix Aqua, Proclear, Frequency 55, Biofinity, Air Optix Night & Day, Purevision 2
Replacement Schedule

- Quarterly
- Examples: Intelliwave, Preference, Alden Astera, SpecialEyes

Replacement Schedule

- Packaging
  - blister packs (90, 30, 6, 4, 2-packs)
  - vials (single, 2, 3, 4-packs)

Replacement Frequency
How to Decide

- Manufacture recommendation
- Physical / physiologic factors
- Philosophy
- Budget
- Parameter availability
- Compliance
Soft Contact Lens Design and Fitting

Anatomy of a Soft Contact Lens

Anatomy of a Soft Contact Lens
Material Properties

Parameter Ranges (extremes)

- Diameters
  6.0 to 18.0 mm
- Water Content
  25 to 79%
- Center Thickness
  0.035 to 0.45 mm
- Powers
  Sphere: +50.00 to -75.00
  Cylinder: 0.00 to -15.00

Material Properties

Typical Parameter Ranges

- Diameters
  13.8 to 14.5 mm
- Water Content
  38 to 60%
- Center Thickness
  0.06 to 0.2 mm
- Powers
  Sphere: +6.00 to -12.00
  Cylinder: 0.00 to -2.25

SCL Design Factors

- Lens Diameter
- Base Curve Radius
- Center Thickness
- Anterior Surface
  - Spheric
  - Aspheric
Lens Diameter

1.0 mm of Scleral Drape
HVID 11.8 mm, Lens Dia. 13.8 mm

Lens Diameter 13.8 mm
Corneal 12.8 mm
Cornea 10.5 mm
Large 12.8 mm Cornea
Small 10.5 mm Cornea

SCL Design Factors
• Lens Diameter
• Base Curve Radius
• Center Thickness
• Anterior Surface
  – Spheric
  – Aspheric
Sagittal Depth of a Soft Lens

1. Base Curve Radius
2. Overall Lens Diameter

Sagittal Height

Base Curve Radius = 8.60 mm

Base Curve Radius
0.3, 0.2 mm or Single Increments

Overall Lens Diameter = 14.0 mm
- Steep Base Curve = 8.30 mm
- Med. Base Curve = 8.60 mm
- Flat Base Curve = 8.90 mm
  or
- Steep Base Curve = 8.40 mm
- Flat Base Curve = 8.60 mm
  or
- Med. Base Curve = 8.60 mm
Effect of Radius on Base Curve

Variable Base Curves

Soft Contact Lens Fitting

Step #1 Measure the patients HVID and select an overall lens diameter 2.0mm larger.
Step #2 Obtain central "K" readings.
Step #3 Select a BC (steep, medium, or flat) based on the corneal diameter and central "K‘ s".
Step #4 Following lens equilibration, evaluate fitting relationship for centration and movement.

Lens Settling or Equilibration Time

A settling time is approx. 5 to 10 minutes due to differences in the temperature, pH and osmolarity of the lens in the foil pack or the lens on the eye.
Base Curve Fitting Relationship
Too Flat
Too Steep
Ideal

Optimum Soft Lens Fit
- Will be comfortable
- Display good centration overlapping the limbus by approx 1.0 mm.
- 0.25 mm to 0.5 mm of movement with a blink in primary gaze.
- 0.5 mm to 1.25 mm movement with blink in up gaze.

Optimum Base Curve Fitting Relationship
**Push up Test**

**Procedure:**
1. Digitally move lens upward
2. Observe re-centering

**Assessment:**
1. Amount of force necessary to dislodge
2. Speed of re-centration

**Ideal:**
Easy movement with the push-up-test and smooth re-centering.

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**Push up Test**

**Tips:**
1. If de-centered up may be difficult to dislodge giving false impression of tightness therefore re-center lens and re-perform.
2. If lens dehydrates may have limited movement giving false impression of tightness therefore dislodge (flushing tear beneath) and re-perform.
3. Keep lower lid apposed to globe (don’t allow to roll away)

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**Base Curve Radius**

*With “Normal” Corneal Diameters*

The Base Curve Radius of a thin, flexible SCL design, will fit a wide range of corneas.
Flat Soft Lens Fit

- May be uncomfortable due to excessive lens movement or decentration.
- May exhibit either excessive or minimal movement.
- Is easily dislodged on the push-up-test.
- May exhibit an edge that shows some stand off, “fluting”.

Edge Fluting

Tips on Lens Movement

- 0.3mm was optimum cut-off point for identifying loose, however 31% of tightly fitting lenses showed >0.3mm decentration, lenses (Graeme Young 1996)
- Very flexible lenses move little due to conformity (secondary to thin post-lens tear film and larger shear forces thin films induce)
Sagittal Depth Too Shallow

LenToo Flat

1. Steepen the Base Curve Radius
2. Increase the Overall Lens Diameter

CL Too Flat

Altering a Flat SCL Fit

Base Curve Radius
• Steepening the BC radius (8.60 to 8.30 mm) tightens the lens fit.
Altering a Flat SCL Fit

Overall Lens Diameter

- Increasing the lens diameter (14.0 to 15.0 mm) **tightens** the lens fit.

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CL Too Flat

Tip: Manually center the SCL with finger and see if coverage is OK, if it is then you know diameter is correct therefore need to change base curve.

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CL Too Flat?

*Everted SCL*
BC Optimum or Too Steep?

Steep Soft Lens Fit

- May be initially comfortable but may ache or feel tired later in the wearing schedule.
- Displays little or no movement with a blink.
- Difficult to dislodge by the push-up-test.

Base Curve Too Steep
Sagittal Depth Excessive

_Lens Too Steep_

1. Flatten the Base Curve Radius
2. Decrease the Overall Lens Diameter

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**Altering a Steep SCL Fit**

**Base Curve Radius**
- Flattening the BC radius (8.60 to 8.90 mm) _loosens_ the lens fit.

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**Altering a Steep SCL Fit**

**Overall Lens Diameter**
- Decreasing the lens diameter (15.0 to 14.0 mm) _loosens_ the lens fit.
Labeled vs Actual Base Curve Radius

- An 8.4 (steeper BC) Vistakon Acuvue is flatter than an 8.7 CooperVision Preference.
- Analogy: fitting difference between shoes.

Lid Interaction

- Lid may cause:
  - Decentration
  - Variable movement characteristics
- Often overlooked

Tear Exchange Beneath Contact Lenses

- **RGP Lenses**
  20% per blink
- **Soft Lenses**
  1% per blink
Importance of Tear Exchange

- Oxygen
- Nutrient
- Remove debris
- Eliminate metabolic waste
- Bacterial binding?

Upon application of the lens;
If the patient is noted to be experiencing excessive lacrimation or blepharospasm…suspect…

1. Foreign body beneath CL dust eyelash etc.
2. Solution sensitivity
3. Lens damage
4. Lens inside out
Lens Defects

Sagittal Depth of the Cornea and Contact Lens

Corneal Anatomical Features and Their Contribution to Sagittal Height
Corneal Radius and Sagittal Height

K = 43.00 7.85 mm
Diameter = 11.7 mm

Corneal Shape Factor and Sagittal Height

K = 43.00 7.85 mm
Diameter = 11.7 mm

Corneal Diameter and Sagittal Height

“K” 43.25 D, 7.80 mm
Corneal Diameter and Base Curve Radius

200 Consecutive Right Eyes

Average HVID 11.8 mm

DVID Distribution PU CO Class
**Lens Diameter 14.2 mm**

- Corneal 12.8 mm
- Cornea 10.5 mm

**Corneal Diameter**

- 10.2 mm HVID
- 13.0 mm HVID

**Apical Radius:**
- 46.00 D  7.34 mm
- 41.00 D  8.23 mm
Effective “K”
Used to assist in the selection of base curve radius
Incorporates both the:
1. central corneal radius
2. corneal diameter

Case Example
Step #1 Measure HVID

Corneal Diameter
Step #2 Calculate the Mean “K”

Mean “K” = 43.00 (7.85 mm)

Step #3 Calculate Effective “K”

For every 0.2 mm smaller than 11.8 mm subtract 1.00 D from the Mean K

For every 0.2 mm larger than 11.8 mm add 1.00 D from the Mean K

Corneal Diameter: 12.0 mm (0.2 > 11.8mm)
Mean “K”: 43.00 D (7.85 mm)
Effective “K”: 44.00 D. (7.67 mm)

Step #4 Calculate Lens Diameter

1.0 mm of Scleral Drape
HVID 11.0 mm, Lens Dia. 14.0 mm
Step #5 Calculate BC Radius

Mean “K”: 43.00D
HVID: 12.0 mm
(0.2 mm > 11.8)
Effective “K”: +1.00 D.
44.00 = 7.67 mm
Lens Dia: 14.0 mm
Dia. Factor: 0.70 mm
Final Order:
Base Curve: 8.37 mm
CL Base Curve: 8.4 mm
Lens Diameter: 14.0 mm

Lens Dia. | Fit Flatter
12.0 mm  | 0.00 mm
12.5 mm  | 0.10 mm
13.0 mm  | 0.30 mm
13.5 mm  | 0.50 mm
14.0 mm  | 0.70 mm
14.5 mm  | 0.90 mm
15.0 mm  | 1.10 mm
15.5 mm  | 1.30 mm
16.0 mm  | 1.50 mm
16.5 mm  | 1.70 mm

Case Example

Step #1 Measure HVID

Step #2 Calculate the Mean “K”

Mean “K” = 41.00 (8.23 mm)
Step #3 Calculate Effective “K”

For every 0.2 mm smaller than 11.8 mm subtract 1.00 D from the Mean K

For every 0.2 mm larger than 11.8 mm add 1.00 D from the Mean K

Corneal Diameter: 13.0 mm (1.2 > 11.8 mm)
Mean “K”: 41.00 D (8.23 mm)
Add 6.00 D
Effective “K”: 47.00 D (7.18 mm)

Step #4 Calculate Lens Diameter

1.0 mm of Scleral Drape
HVID 13.0 mm, Lens Dia. 15.0 mm

Step #5 Calculate BC Radius

Mean “K”: 41.00 D
HVID: 13.0 mm
(1.2 mm > 11.8)
Effective “K”: +6.00 D.
47.00 = 7.18 mm
Lens Dia: 15.0 mm
Dia. Factor: 1.10 mm
Final Order:
Base Curve: 8.28 mm
CL Base Curve: 8.3 mm
Lens Diameter: 15.0 mm

<table>
<thead>
<tr>
<th>Lens Dia.</th>
<th>Fit Flatter By</th>
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<tbody>
<tr>
<td>12.0 mm</td>
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<tr>
<td>16.5 mm</td>
<td>1.70 mm</td>
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</tbody>
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Air Optix Aqua 8.6 14.2

Right Eye Left Eye

Custom SCL’s 8.3 / 15.0 mm

Right Lens Left Lens

Sagittal Height
Soft Lens Fitting by Sagittal Height

Anatomical Features that Contribute to Sagittal Height

1. Central Corneal Curvature
2. Corneal Eccentricity
3. Corneal Diameter
4. Scleral Angle

Soft Lens Options
- Yearly replacement
- Quarterly replacement
- One month replacement
- Two week replacement
- One week extended wear
- Daily disposable
- 30-Day continuous wear