CONTACT LENSES 1

By
Hatem S.H. Barhoom
MHSC (clinical optometry)
UKM – Malaysia
INTRODUCTION

Contact lens is a small plastic wafer designed to set on the cornea or sclera

• 1508 : L. Da vici >>> glass cups containing water >>> C.Ls

• 1636 : Decart >> first describe a CL resting upon the cornea

• 1801 : young >> water filled lens
• 1823 Herschel >> cornea-like mould to treat irregular astigmatism

• Fick: tried to make C.L made of glass to replace irregular astigmatism

• 1881: Javal & Schiots >> keratometer

• 1930: first applicable C.L, scleral, large, thick used for keratoconous, limited wearing time

• 1947: Kevin >> C.L from PMMA, large $\phi$, thick > corneal edema
• 1952: Wolhem >> smaller $\phi$, corneal, thinner

• Now: C.L smaller >> 7-8 mm $\phi$

• new materials such as: silicon, and flurocarbon >> rigid gas permeable (RGP)
INDICATIONS

- Cosmetic:
  
a. Unsightly eye >> opaque pupil (no useful vision)
     clear pupil (useful vision): adherent leucoma, aniridia.

- Athletics: C.L provides wider field, better optics, avoid serious injuries.
• Working is steamy or rainy atmospheres to avoid fogging

• Optical:
  – Myopia
  – Hyperopia
  – Astigmatism
  – Presbyopia
  – Keratoconous
  – Aphakia
  – Anisometropia and anisokonia
  – Albinism >> multiple holes
  – Nystagmus
  – Orthokeratology
• Therapeutics:
  – Persistent epithelial defects
  – Recurrent corneal erosions
  – Bollus keratopathy
  – Wet filamentary keratitis
  – Desmatocele
  – Protection of cornea >> entropin, exposure keratopathy
  – After corneal grafts >> as splits

• Diagnostic: electrodes > ERG
• Research.
CONTRA INDICATIONS

• Systemic causes:
  – Pregnancy and menopause >> corneal edema
  – Oral contraceptive pills >> dry eyes
  – Uncontrolled diabetes >> unstable refraction
  – Thyroid disease >> exophthalmose
  – 5th N palsy >> loss of sensation
  – 7th N palsy
  – Poor hygiene
  – Personal dexterity
  – Handling problems
  – Age >> children(2-10years) or elderly
• Eye diseases:
  – Stye, chalayzion
  – Conjunctivitis, symblepharon, pterygium
  – Corneal epithelial dystrophy, pannus formation, corneal ulcer, keratitis
  – Dry eye, scleritis, uveitis
DISADVANTAGES OF C.L

- Needs special care: cleaning, disinfecting, and storing
- Insertion and removal
- High cost
- Cannot be used in some systemic of ocular diseases
- Can cause problems in the eye such as GPC
C.L PROBLEMS

- BC >> steeper, flatter
- Decentration
- Vertical striae due to corneal hypoxia
- Limbal compression due to tight lenses
- O2 deficiency
- Edema of cornea
- Allergy
• Diminished evaporisation

• Spectacle blur

• Flare or streaming of lights >> large pupil with prismatic displacement

• Blurring of vision in day time through normal pupil
• Corneal abrasion

• Blurring after reading >> in myopia

• Corneal warpage due to poorly fitted lenses

• Deep neovascularisation
OPTICS OF CONTACT LENS

• Eliminate the cornea as a major source of refractive power.

• Fills out the irregularities between C.L and cornea

• The change in refractive power is produced by altering the curvature of the contact lens
How To Find B.C For Contact Lenses

\[ K = \frac{n-1}{r} \]

\[ B.C = r = \frac{n-1}{K} \]

Example:
K readings = \( K_1 = 45 \) D, \( K_2 = 47 \)D
\( n = 1.3375 \)
\( r = ?? \)

Answer:
\( K_{Avg} = \frac{(45 + 47)}{2} = 46 \)

\[ r = 1.3375 - 1 / 46 = 0.0073 \text{ m} = 7.3 \text{ mm} \]
How to convert spectacle to contact lens

In thick lenses: \( F_{\text{total}} = \frac{F_1}{1 - t \frac{F_1}{n}} + F_2 \)

\[
F_{\text{total}} = \frac{F_s}{1 - d \frac{F_s}{n}} + F_{\text{CL}}, \quad n = 1
\]

\[
0 = F_s / (1 - dF_s) - F_{\text{CL}}
\]

\[
F_{\text{CL}} = \frac{F_s}{1 - dF_s}
\]
Example:

\( F_s = -5.00 \, Ds \)

\( d = 12 \, \text{mm} \)

\( \Rightarrow F_{CL} = ?? \)

Answer:

\[ F_{CL} = \frac{F_s}{1 - dF_s} = \frac{-5.00}{1 - 0.012 \times -5.00} = -4.75 \, Ds \]
Example:

\[ F_s = -5.00 \text{ Ds} / -2.00\text{Dc} \times 90 \]

\[ d = 12 \text{ mm} \]

\[ \gg F_{cl} = ?? \]

Answer:

\[ F_{-5.00} = F_s / (1 - dF_s) = -5.00 / (1 - 0.012 \times -5.00) = -4.75 \text{ Ds} \]

\[ F_{-7.00} = F_s / (1 - dF_s) = -7.00 / (1 - 0.012 \times -7.00) = -6.50 \text{ Ds} \]

\[ F_{cl} = -4.75 \text{ Ds} / -1.75\text{Dc} \times 90 \]
Accommodation and convergence demand in CL

\[ \text{Acc} = 3.00 - 0 = 3.00 \text{ Ds} \]
In myopia:

Accommodation demand:

\[ F_{\text{total}} = -7.00 + \left( \frac{1}{\infty} \right) = -7.00 \ \text{Ds} \]

\[ F_P = \frac{F_{\text{total}}}{1 - dF_{\text{total}}} = \frac{-7.00}{1 - 0.015 \times -7.00} = -6.33 \ \text{Ds} \]
F_{total} = -7.00 + (-1/0.3333) = -10.00 \text{ Ds}

F_P = \frac{F_{total}}{1 - dF_{total}} = \frac{-10.00}{1 - 0.015\times -10.00} = -8.70 \text{ Ds}

So, Accommodation needed: 8.70 – 6.33 = 2.37 D

Which is less than accommodation demand in case of CL (3.00 – 2.37) by 0.63 D
Convergence demand:

Induce BI prismatic effect

Less convergence
In Hypermetropia:

Accommodation demand:

\[
F_{\text{total}} = 7.00 + \frac{1}{\infty} = 7.00 \text{ Ds}
\]

\[
F_P = \frac{F_{\text{total}}}{1 - dF_{\text{total}}} = \frac{7.00}{1 - 0.015 \times 7.00} = 7.82 \text{ Ds}
\]
Vergence from 33.33 cm

\[ F_{\text{total}} = +7.00 + \left( -\frac{1}{0.3333} \right) = +4.00 \text{ Ds} \]

\[ F_P = \frac{F_{\text{total}}}{(1 - dF_{\text{total}})} = \frac{+4.00}{(1 - 0.015*+4.00)} = +4.26 \text{ Ds} \]

So, Accommodation needed: \( 7.82 - 4.26 = 3.56 \) D

Which is more than accommodation demand in case of CL (3.56 – 3.00) by 0.56 D
Convergence demand:

Induce BO prismatic effect

More convergence
Field of vision

- No obstruction of VF by spectacle frame
- No peripheral distortion

Image Size

- Retinal image is influenced by the vertex distance of the corrective lens
- $M = 1/(1-dF)$, $d =$ distance between pupil entrance and lens in meters
Example 1:

\[ F = +10.00 \text{ Ds} \]
\[ d = 15 \text{ mm} \]
\[ M = ?? \]

Answer:

\[ M = \frac{1}{1 - (0.015 \times 10)} = 1.176 \]
>> increase by 17.6%  
(magnification)

Example 2:

\[ F = -10.00 \text{ Ds} \]
\[ d = 15 \text{ mm} \]
\[ M = ?? \]

Answer:

\[ M = \frac{1}{1 - (0.015 \times -10)} = 0.87 \]
>> decrease by 13%  
(minification)
Example 1:

F = +10.00 Ds

\(d = 3 \text{ mm}\)

M = ??

Answer:

\[F_{CL} = \frac{F_s}{1 - dF_s} = +11.76\]

\[M = \frac{1}{1 - (0.003 \times 11.67)} = 1.05\]

>> increase by 5.2 \% (magnification)

Example 2:

F = - 10.00 Ds

\(d = 3 \text{ mm}\)

M = ??

Answer:

\[F_{CL} = \frac{F_s}{1 - dF_s} = -8.70\]

\[M = \frac{1}{1 - (0.003 \times -8.7)} = 0.974\]

>> decrease by 2.6 \% (minification)
In aphakia and high myopia

- In aphakic patients using spectacles: plus corrective lens + high imaginary minus = Galilean telescope (magnification).
  \[ M = \frac{\text{power of ocular}}{\text{power of objective}} \]

- Even in aphakic patients using CL there will be some magnification because CL is not located on the nodal point.

- In high myopes using spectacles: minus corrective lens + high imaginary plus = reverse Galilean telescope (minification)

- Even in high myopic patients using CL there will be some minification because CL is not located on the nodal point.
Contact lens performance requirements

- CLs are used usually for optical correction

Three main requirements:

1. Correct the patient’s vision (see well)
2. Doesn’t cause any harm (look well)
3. Comfort (feel well)

Optometrist should choose the appropriate lens type to meet these three criteria
Haptic (Scleral) Lenses

- 25-30 mm $\phi$

- Cover the whole cornea and rest on sclera
  - The lens vaulted and filled with fluid

- The first haptic was made from Glass and later from plastic
  - Cause corneal edema

- New designs are fluidless
  >>> only thin layer of tears under CL
• Difficult fitting because it needs exact matching of the shape of the eye

• Used in:
  – Severe keratoconous
  – Very irregular cornea
  – Ocular surface disorders: Steven–Johnson syndrome
Corneal lenses

- Kevin Touhy cut the haptic lens to about 11.5 mm

- Rest on cornea, newer designs >>> 8-10mm φ

- It moves with blinking >>> more tear exchange >>> less edema

- Easier in fitting than haptic
• Made of PMMA
  – PMMA impermeable to oxygen >>> more edema

• To increase $O_2$:
  
  – Additional curves added to periphery. >>> increase tear exchange

  – PMMA copolymerized with silicon (high $O_2$ permeability, flexible and hydrophobic) and/or Flurocarbone and/or methacrylic acid MAA and/or polyvinyl pyrolidone PVP
The different % of these materials will give different characteristics:

- Silicone = Oxygen permeability, flexibility
- Methacrylic acid and PVP = Wetting agents (hydrophilic)
- Methylmethacrylate = Mechanical and optical stability
Hydrogel (soft) lenses

- Otto and Lim developed a hydrogel material and made CL of it

- Hard in dehydrated state, flexible in hydrated state

- HEMA: hydroxy ethyl meth acrylate
  - Corneal edema
  - Deposits built up
  - Fragile

- To increase $O_2$ permeability:
  - Thinner lenses up to 0.035 mm
  - Silicon $>>$ silicon hydrogel
  - Increase water contents
    - Low water content (less than 40 percent water)
    - Medium water content (50 to 60 percent water)
    - High water content (more than 60 percent water)
• 13.5 – 14.5 mm φ
  – Edge beyond limbus >> give good centration and comfort.

• Soft and flexible
  – No many BCs are needed to cover wide range of eye shapes
• Advantages:
  
  – Excellent initial comfort
  – Rapid adaptation
  – Minimal corneal edema
  – Minimal lens loss
  – Minimal over wear reaction >> due to tear exchange
  – Less flare >> due to minimal movement
  – Large size >> corneal protection
  – safe >> Ideal for infants and children
  – Invisible
• Disadvantages:
  – Absorb harmful fluids
  – High cost
  – Limited in high astig > 1.5 D
  – Lens deposits
  – Impossible modification
Rigid Gas Permeable (RGP)

- $O_2$ permeability was achieved by adding silicon to PMMA.
- Surface wettability increased by >> MAA ,and Flouruine
• In fitting (by fluroscine):
  – Slight touch centrally
  – Edge clearance
Oxygen Permeability (DK)

- **Diffusion:**
  
  "D" is the inherent ability of the material to allow oxygen to diffuse through holes or voids in the plastic.

- **Solubility:**
  
  "K" represents the degree to which oxygen is solubilized (adsorbed) within or on a material.

- The higher the number the greater the oxygen permeability.
  - PMMA Dk = 0
  - Paragon HDS DK = 100, Boston XO Dk = 100
Oxygen Transmissibility

- A materials oxygen transmissibility is known as its $Dk/t$
  - “$Dk$” is the materials permeability to oxygen.
  - “$t$” is the thickness of the lens.
- Classification:
  - Low $Dk$ is $< 12$
  - Medium $Dk$ is 15-30
  - High $Dk$ is 31-60
  - Super $Dk$ is 61-100
  - Hyper $Dk$ is $> 100$
Design and Nomenclature of Contact Lenses
Lens Design


2. Aspheric: different radii of curvature in the center and periphery, simulating the structure of the cornea.
3. Toric:
   - two principal meridians have different radii of curvature (this may be the anterior or posterior surfaces of the lens or both).
   - Used to correct astigmatism.
     - Front surface toric lenses
     - Back surface toric lenses
     - Bitoric lenses (when both the anterior and posterior surfaces are toric)
4. Bifocal

5. Progressive
7. Multicurve (two or more posterior curves).

8. Reverse curve (a central posterior curve, which is flatter, utilized primarily for fitting after refractive surgery for myopia or orthokeratology).
9. Single-cut: The anterior surface of a single-cut contact lens is a continual curvature

10. lenticular

- Simple design
- Flat border
- Positive border
- Lenticular with negative border
Nomenclature of Contact Lenses

- Lens diameter (Total diameter)
- Anterior cap diameter
- Optic zone of the lens
  - Back optic zone diameter

![Diagram showing the parts of a contact lens: Front surface, Back surface, Optic zone diameter, Anterior cap diameter, Total diameter.](image-url)
• Base curve and secondary curves:
  o BCR = BOZR = PCCR = BCOR = PAR
  o Bicurve,
    o SCR = PSCR = BPOR
    o SCW
  o Tricurve
    o TCR = BPOR^2
    o TCW
  o Blend to increase comfort
• Lens thickness

1. Central thickness of the lens
   - Power
   - The peripheral curve
2. *Edge thickness*

Simple design  |  Flat border  |  Positive border  |  Lenticular with negative border

EC = Edge clearance
REL = Radial edge lift
AEL = Axial edge lift
• Sagittal depth

\[ s = \frac{y^2}{2r} \]

Tight or loose fit is controlled by two variables: diameter and radius of curvature

\[ D = 2y \]
When diameter is constant

smaller radius of curvature will give larger sag
When radius of curvature is constant

Larger diameter will give larger sag
• Lens power:
  o Back vertex power
  o Anterior vertex power

• Tints:
  o Handling tint
  o Enhancing tint
  o Opaque tint
  o UV-blocking tints

• Keratometer:
  o Astigmatism with the rule
  o Astigmatism against the rule
FACTORS AFFECT OPTICAL CORRECTION
- Vertex distance:
  - More than 4.00 D
  - Each meridian will be considered separately
  - \( F_{CL} = F_s / (1 - dF_s) \)
• Lacrimal or tear lens:
  
  – If back curve doesn’t match the corneal curvature >>> tear lens or lacrimal lens
    • Flatter CL will give minus tear lens
    • Steeper CL will give plus tear lens
  
  – Tear lens will correct astigmatism equal to the corneal toricity.
  
  – Soft CL >> soft and flexible >> take the shape of the cornea >> no significant tear lens
• Residual astigmatism

  – The astigmatism that is not corrected by spherical CL.

  – Spectacle toricity doesn’t match the spectacle astigmatism (corrected from vertex distance).

  – With spherical hydrogel lenses the residual astigmatism usually equals the spectacle cylinder (corrected for vertex distance)
Anatomy and physiology of cornea

• Gross anatomy:
  
  – Elliptical anterior surface:
    • Vertical plane >> 11mm
    • Horizontal plane >> 12mm
  
  – CCT >> 0.58 mm, 1mm in periphery
    • The thickness increases with age
  
  – The central third of cornea is spherical
- Flattening peripherally >> not symmetrical

- The Keratometer measures small spherical central area (3.5-4 mm)
  - Spherical in infancy
  - Astigmatism with the rule in childhood and adolescence
  - Spherical in middle age
  - Astigmatism against the rule in elderly
Microscopy:

- Epithelium 5 – 7 layers (50 – 90 µm)
  - Basal cells >> one layer
  - Wing cells >> two layers
  - Superficial layers >> 3 layers of squamous and flattened cells non-keratinized

Function:

- Mechanical barrier to microorganisms
- Barrier to the diffusion of water and solutes
- Creating smooth, transparent optical surface >>> adsorb tear film.
Bowman’s membrane (8-14 µm)
- It is a condensation of the superficial stroma which consist of collagen fibrils

Stroma:
- 90% of corneal thickness
- Function:
  - Transparency
  - maintain fixed shape
  - Protect intraocular contents
– Descement’s membrane (6-10 µm)
  • Produced by endothelium
  • Can be regenerated
  • Elastic

– Endothelium (4.5 µm)
  • Hexagonal
  • 3000cells/mm² decrease with age
  • Less than 500 cells /mm² edema occurs
  • Function :
    – Nutrients to cornea
    – Pumb mechanism >> prevent edema >> maintain transparency
• Precorneal tear film

  — Functions:
    • Moistures and lubricates the anterior surface of the globe.
    • Provide smooth optical surface
    • Remove desquamated corneal cells and bacteria
    • Contains Lysozymes which destroy bacteria
    • Source of oxygen
    • Slight nourishment to corneal epithelium
— Structure:
  • Lipid layer
    — Secreted by Meibomian, Zeis and Moll glands
    — Increase the surface tension of tear film
    — Decrease rate of evaporation
  • Aquous layer
    — Reflex secretion >> main lacrimal glands
    — Basic secretion >> Krause and Wolfring
    — Prevent epithelial drying
  • Mucous layer:
    — Secreted by goblet cells of conjunctiva
    — Decrease the surface tension >> aquatic adsorbed to epithelial surface
    — Maintain intact tear film for 15-20 seconds between blinks
Parameters required for contact lens fitting

- Height of palpebral fissure
  - Normal height = 10 mm >> every 0.50 mm increase = 0.2 mm larger diameter

- Corneal diameter (The horizontal visible iris diameter) (HVID)
  - Larger cornea need larger diameter for stabilization

- Corneal curvature
  - Flat corneas need larger diameter
  - Steep corneas need smaller diameter
• Pupil diameter
  – Necessary to avoid flare in dim illumination
  – Large pupils (5-7mm) in persons with blue eyes, myopia, anxiety.
    • Optic zone should be increased 0.5 mm

• Lid tightness
  – Tight lids
    • Ride high lens
    • Move excessively with blink
  – Loose lid demands lens diameter bigger by 0.2 – 0.5 mm
• Adequacy of tear secretion
  – Critical factor to determine the suitability to wear CL
  – Evaluated by
    • Schirmer’s test
    • BUT

• Blink rate
  – Should be at least one blink every 15 – 20 sec
Methods of Evaluating a Patient before Prescribing Contact Lens
A. Patient discussion

1 – personal details :
   • Occupation
   • Recreational activities
   • The age
   • Patient dexterity and hygiene habits
   • Handling problems
   • Complexion

2- contact lens specific :
   • Motivations and expectations
3- general history:
   • History of systemic diseases and conditions
   • History of systemic medication

4 – ocular history:
   • Refraction correction, past and present
   • Ocular disease history:
     o Dry eyes
     o Muscle imbalance
     o Any ocular symptoms
   • Any previous contact lens wearing: reasons of any previous failure.
   • Previous refractive or ocular surgeries
B. Full eye examination:

- Lid margin.
- Conjunctiva.
- Cornea >> scars, opacities, edema, neovascularization.
- Muscle balance.
- Refraction and fundus examination.
- Height of palpebral fissure.
- HVID.
- Pupil size.
- Lid tension.
- Blink rate.
- Adequacy of tear secretion.
- Corneal curvature.
Systems for RGP lenses Fitting
1. Trial (diagnostic) fitting is the preferred method by most practitioners

   - Diagnostic lens will be used to determine the major and minor irregularities in the contour of the cornea.

   - Small number of lenses in the diagnostic set about 20 lenses

2. An inventory system:

   - The precise lens can be tried and fitted at the time of examination

   - Large trial set PMMA set contains 400 – 600 lenses.
3. The empirical fitting:

- Is a simple method that generates a design based on patient data.

- No contact lenses are placed on the eye until the ordered contact lenses are received and dispensed.

- An empirical fitting method, or direct ordering, ensures that a new, unworn lens is placed on the eye.

- Compared with diagnostic fitting, the empirical fitting philosophy produces lower success rates and less patient confidence in the practitioner.
a. Mandell’s empirical method (referred to as custom).

- The custom contact lens is defined by factors such as corneal diameter, lid position, lid tension, scotopic pupil size, and K readings.

b. Harrison and Stein use a nomogram

- Diameters are increased as base curves flatten.

c. Computer programs are available for lens design.

- Corneal topographers can come equipped with fluorescein pattern simulators and lens design programs.
- Other information such as axial edge lift and flexure can be given.
RGP lenses Fitting
1. BC:

- K readings are taken by keratometer
- If corneal cylinder < 0.75, select flattest K
- If corneal cylinder 1.00 – 2.00, add 25% difference to flattest K
- If corneal cylinder > 2.00, add 33% difference to flattest K
2. Diameter: This depends on many factors such as:

- Corneal curvature >> optical cap + 2mm, flat cornea needs larger diameter
- Width of palpebral fissure
- Eye lid tightness
- Pupil size

For example:

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Pupil size in dim illumination (mm)</th>
<th>Corneal curvature (D)</th>
<th>Palpebral fissure size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8-9.0</td>
<td>≤6</td>
<td>≥45</td>
<td>≤9.0</td>
</tr>
<tr>
<td>9.2-9.4</td>
<td>6-8</td>
<td>42</td>
<td>9.0-10.5</td>
</tr>
<tr>
<td>9.6-9.8</td>
<td>≥8</td>
<td>≤42</td>
<td>≥10.5</td>
</tr>
</tbody>
</table>
3. Power calculations:

a. Over refraction: refraction while CL is worn

b. Short method:

- If lens fitted on K and spectacle power $< \pm 4.00$ D
  - Transpose to minus cylinder $\gg$ drop the cylinder

- If lens is not fitted on K (tear lens will be created)
  - For every $0.25$ D steep than K $\gg$ add $-0.25$ D to the power

- If spectacle power $> \pm 4.00$ D
  - Use the equation $F_{CL} = F_s / (1 - dF_s)$
c. Long method

- Spectacle power is recorded at corneal plane
- Corneal cylinder is taken as minus cylinder with axis along the flatter meridian
- Ensure that corneal cylinder axis and spectacle cylinder axis are the same.
- Subtract the corneal cylinder from spectacle correction.
- The result is the CL power
Spectacle cylinder
= corneal + internal
- 2.00 Dc \times 120
(at corneal plane)

Corneal cylinder
- 2.00 Dc \times 120

Internal cylinder
0.00

Residual astigmatism = 0.00
Corneal and spectacle cylinder have the same power and axis

Example:

1. Corneal plane refraction = -2.00 Ds/ -1.00 Dc × 180

2. \( K1 = 45.00 \@90, \ K2 = 44.00 \@180 \rightarrow -1.00 \text{ cyl} \times 180 \)

3. Residual astigmatism = 0.00 (spectacle Cyl-corneal Cyl)

4. All the cylinder will be corrected by the CL >> the CL power = -2.00 Ds
Spectacle cylinder = corneal + internal

- 2.00 Dc × 120 (at corneal plane)

Corneal cylinder
- 1.50 Dc × 120

Internal cylinder
- 0.50 Dc × 120

Residual astigmatism = - 0.50 Dc × 120
Corneal cylinder is less than spectacle cylinder (same axis)

Example:

1. Corneal plane refraction = -2.00 Ds/ -1.00 Dc × 180

2. K1 = 45.00 @ 90, K2 = 44.50 @ 180 >> -0.50 cyl × 180

3. Residual astigmatism = -0.50 (spectacle Cyl-corneal Cyl)

4. Corneal cylinder only will be corrected by the CL >> the CL power = -2.00 Ds / -0.50 Dc × 180
Spectacle cylinder = corneal + internal

- 2.00 Dc × 120 (at corneal plane)

Corneal cylinder
- 1.50 Dc × 30

Internal cylinder
+ 3.50 Dc × 30

Residual astigmatism = +3.50 Dc × 30
Corneal and spectacle cylinder are 90 apart

Example:

1. Corneal plane refraction = -5.00 Ds/ -1.50 Dc × 90

2. K1 =44.75 @ 90 , K2 = 43.25 @ 180 >>> -1.50 cyl × 180

3. -6.50 Ds/ +1.50Dc × 180

4. Residual astigmatism = +3.00 (spectacle Cyl-corneal Cyl)

5. Corneal cylinder only will be corrected by the CL >> the CL power = -6.50Ds / +3.00Dc × 180
Spectacle cylinder = corneal + internal

-2.00 Dc $\times$ 120 (at corneal plane)

Corneal cylinder

- 2.50 Dc $\times$ 120

Internal cylinder

+ 0.50 Dc $\times$ 120

Residual astigmatism = + 0.50 Dc $\times$ 120
Corneal cylinder is more than spectacle cylinder (same axis)

Example:

1. Corneal plane refraction = \(-2.50 \text{ Ds} / -1.50 \text{ Dc} \times 180\)

2. \(K_1 = 47.00 \, @ \, 90\), \(K_2 = 44.00 \, @ \, 180 \gg \gg -3.00 \text{ cyl} \times 180\)

3. Residual astigmatism = +1.50 (spectacle Cyl-corneal Cyl)

4. Corneal cylinder only will be corrected by the CL >> the CL power = -2.50Ds / +1.50Dc × 180
Spectacle cylinder = corneal + internal

-2.00 Dc × 120 (at corneal plane)

Corneal cylinder = 0.00

Internal cylinder = -2.00 Dc × 120

Residual astigmatism = -2.00 Dc × 120
Cornea is spherical!!

Example:

1. Corneal plane refraction = -3.00 Ds/ -2.00 Dc × 180

2. K1 =44.00 @ 90, K2 = 44.00 @ 180 >>> 0.00

3. Residual astigmatism = -2.00 (spectacle Cyl-corneal Cyl)

4. Corneal cylinder only will be corrected by the CL >>> the CL power = -3.00Ds / -2.00Dc × 180
Insertion and Removal of RGP
Preparing the RGP lenses for wearing

Cleaning first before touch the RGP

- Wash your hand with mild soap
- Rinse completely
- Dry with lint-free towel
- Avoid soaps contain cold cream, lanolin or perfumes
- Avoid use of oily cosmetics prior to handling the lenses
- These substances can adhere to lens surfaces affecting both vision and wearing comfort.
Handling

• Handle the lens with your fingertips

• Avoid contact with fingernails

• Always work with the same lens first, to avoid mix-ups.

• Check the lens and make sure it is moist, clean, clear, and free of any chips or cracks!!

• Rinse with fresh conditioning solution
Insertion by practitioner

- concave side up on the tip of the index or middle finger
- dry finger, wet lens
- the patient is instructed to look down
- the tip of index and middle finger is placed on the upper lid margin
- The lid is pulled up >> unable to blink
- The patient is then instructed to look into a mirror >> to counteract Bell's phenomenon
- The lower lid is gently pulled down by the tip of either the middle or the ring finger of the hand holding the lens
• The lens is then applied to the cornea

• Release lids and blink >> centration

• Verify proper position by check vision after insertion.

• Use the same for the other eye

• If after placement the lens, the vision is blurred !
  
  o Not centered
  o if well centered then check for cosmetics or oils on the lens (remove and clean the lens)
  o The lens is on the wrong eye
Removal by practitioner

- Squeeze the lens off by the thumbs of each hand by applying pressure on the upper or lower lids respectively

- apply the finger of one hand to the outer canthal region, resting on the upper and lower lids >> eye should be kept wide open >> lid margin can engage the lens >> a voluntary blink >> dislodge the lens
Insertion by patient

• The patient should look straight or looking in a mirror

• The upper lid should then be held at lashes with finger of opposite hand.

• The lower lid should be held with middle finger or ring finger of the hand that holding the lens.

• The index finger carrying the lens gently applied to cornea

• Slowly release the lower lid, then the upper lid

• Blink to center the lens
Removal by patient:

1. the lens should always be centered before removal.

2. the patient should look downwards and to cup the opposite hand under the eye to catch the lens.

3. the fore finger is placed on the outer corner of the eye led, and the lid is pulled aside at the same time, the patient blinks, the lens usually "pop out".
Alternatively:

1- the two handed – method:
Pushes the lids under the lens, one finger of each hand grasps the upper and lower lids, The lids are pushed toward the contact lens squeezing it out of the eye.

2- The scissor-method

3- pull and blink
Recentering a displaced lens:

- First find the lens in any quadrant

- Closed eye:
  - Manipulate the lens by the fingers through the closed lid until it is centered.
  - Move the eyes in a direction opposite to position of the lens, the lens is centered by manipulation and held there, then the eye rotated centrally, sliding under the held lens.
  - Pinion the lens by the index fingers of both hands and rotate the eyes slowly towards the lens until it moves under it

- Opened eye:
  - Push the lens into position by using the upper and lower lid margins.
  - This method applied only for superiorly and inferiorly displaced lenses.
Notes:

- New patients should be observed inserting and removing their lenses at least three times.
- Established wearers should be observed at least once to ensure that their technique is safe.
- Occasionally, they may need to be re-educated.
4. Peripheral Curves:

- New RGP lenses are designed with one or more peripheral zones that are deliberately intended to lift away from the cornea.

- Most modern spherical lenses are based on these designs.
a) Bicurve (C2)

- Consists of a central radius and one flatter peripheral curve.
- There is a sharp transition between the two curves.

Examples: 7.80:7.00 / 8.70:9.00
           7.80:7.80 / 10.50:9.00

The first peripheral curve should be at least 0.70mm flatter than the BOZR and rather more for lenses at the flatter end of the scale.
b) Tricurve (C3)

- Consists of a central radius and two flatter peripheral curves
- It is the basic design of most modern hard lenses, where the final curve is much flatter than first peripheral radius.

Example: 7.80:7.80 / 8.50:8.70 / 10.50:9.50

For a tricurve, the final peripheral curve is typically chosen as 10.50mm, with a width of 0.50-1.00 mm.
c) **Multicurve**

- Consists of a central radius and three or more peripheral curves.
- It follows the flattening of cornea better than bicurves and tricurves.
- When the transitions are well blended, behaves like a continuous curve lens.

Edge lift:

- Lenses are sometimes designed by deciding on the AEL required and calculating the peripheral curves needed.
- The usual value of axial edge lift varies between 0.09mm and 0.15mm.
  - Tight periphery 7.90:8.00 / 8.60:8.60 / 9.15:9.20, AEL = 0.05mm
  - Average periphery 7.90:8.00 / 9.10:8.60 / 12.30:9.20, AEL = 0.12mm
  - Loose periphery 7.90:7.00 / 8.85:7.80 / 10.40:8.60 / 11.50:9.00, AEL = 0.15mm
- The edge lift of each individual curve contributes to the total figure.
  - 7.40:7.00 / 8.10:7.80 / 9.30:8.60 / 10.50:9.00
  - AEL at 7.80 = 0.025; AEL at 8.60 = 0.095; AEL at 9.00 = 0.15
• If the same increase is given to the peripheral curves of both steep and flat lenses, the steep lens has, relatively, a greater edge lift.

• Example:

\[
\begin{align*}
r & & r + 0.5 & & r + 2.2 & & r + 4.7 \\
8.40:7.00 & & 8.90:8.00 & & 10.60:8.50 & & 13.10:9.00 & \text{AEL} = 0.117\text{mm} \\
7.20:7.00 & & 7.70:8.00 & & 9.40:8.50 & & 11.90:9.00 & \text{AEL} = 0.172\text{mm}
\end{align*}
\]
• Constant AEL (CAEL) lenses are multicurves which for a given TD are designed to give the same AEL throughout the range of radii.

• The clinical appearance and performance are therefore consistent.

Example:

7.40:7.00 / 8.10:7.80 / 9.30:8.60 / 10.50:9.00

Taken from 0.15 mm CAEL trial set with a total diameter (TD) of 9.00 mm.

AEL at 7.80 = 0.025; AEL at 8.60 = 0.095; AEL at 9.00 = 0.15
Concept of edge clearance:

- The term edge clearance relates to the lens on the eye and is estimated by the fluorescein pattern.
- AEL relates to the lens design off the eye.
- Edge clearance relates to the lens on the eye.
- It is inadvisable to alter the BOZR and BOZD in order to adjust edge clearance.
good peripheral clearance looks like a band of green 0.5-0.75 mm wide under the periphery of the lens
RGP Prescription Format
1. lens material:

- Classification code for contact lens materials.

- Each material is classified by a six-part code
  - The prefix : denotes the polymer used.
  - Stem :This is always (focon) for rigid lenses, (filcon) for soft lenses
  - Series suffix : (A) indicates the original formulation., (B) the second version and (C) the third. etc.
  - Group suffix:

<table>
<thead>
<tr>
<th>Group suffix</th>
<th>Rigid lenses</th>
<th>Soft lenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Does not contain either silicon or fluorine</td>
<td>&lt;50% water content, non-ionic</td>
</tr>
<tr>
<td>II</td>
<td>Contains silicon but not fluorine</td>
<td>≥50% water content, non-ionic</td>
</tr>
<tr>
<td>III</td>
<td>Contains both silicon and fluorine</td>
<td>&lt;50% water content, ionic</td>
</tr>
<tr>
<td>IV</td>
<td>Contains fluorine but not silicon</td>
<td>≥50% water content, ionic</td>
</tr>
</tbody>
</table>
- Dk range

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt;1 Dk unit</td>
</tr>
<tr>
<td>1</td>
<td>1–15 Dk units</td>
</tr>
<tr>
<td>2</td>
<td>16–30 Dk units</td>
</tr>
<tr>
<td>3</td>
<td>31–60 Dk units</td>
</tr>
<tr>
<td>4</td>
<td>61–100 Dk units</td>
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<tr>
<td>5</td>
<td>101–150 Dk units</td>
</tr>
<tr>
<td>6</td>
<td>151–200 Dk units</td>
</tr>
<tr>
<td>7,...</td>
<td>Add new categories</td>
</tr>
<tr>
<td></td>
<td>in increments of 50</td>
</tr>
<tr>
<td></td>
<td>Dk units</td>
</tr>
</tbody>
</table>

- Modification code: lower case (m) which denotes that the surface of the lens is modified, having different chemical characteristics from the bulk material.
Example:

Paflufocon B III 3 (Paragon HDS)

- Paflu: USAN prefix.
- focon: Stem, indicating a hard lens material.
- B: USAN series suffix, indicating the second formulation of this polymer.
- III: Group suffix, indicating a material containing both silicon and fluorine.
- 3: Dk in the 31-60 range of ISO units.
2. Lens Parameters

- International Standard terms
- The terminology for a standard tricurve lens in ISO 8320-1986 symbols is:

\[
\begin{align*}
  r_0 : \phi_0 & / r_1 : \phi_1 & / r_2 : \phi_T & t_c & F^{1V} & \text{Tint} \\
  \text{BOZR:BOZD} & / \text{BPZR}_1 : \text{BPZD}_1 & / \text{BPZR}_2 : \text{TD} & \text{BVP}
\end{align*}
\]
Example:

7.90:7.80 / 8.70:8.60 / 10.75:9.20  \( t_c \) 0.15 BVP -3.00D Tint light blue

- 7.90 = back optic zone radius (BOZR) \( (r_0) \)
- 7.80 = back optic zone diameter (BOZD) \( (φ_0) \)
- 8.70 = first back peripheral radius \( r_1 \)
- 8.60 = first back peripheral zone diameter \( (φ_1) \)
- 10.75 = second back peripheral radius \( (r_2) \)
- 9.20 = total diameter \( (φ_T) \)
- 0.15 = geometric center thickness \( (t_c) \)
- -3.00 = back vertex power (BVP)
Example:

7.90:7.80 / 8.70:8.60 / 10.75:9.20 \( t_c \) 0.45 \( t_e \) 0.16  BVP +10.00 D
FOZD 8.30 Tint light blue

- 0.45 = geometric centre thickness \( t_c \)
- 0.16 = edge thickness \( t_e \)
- +10.00 = back vertex power (BVP)
- 8.30 = front optic zone diameter \( \phi_{a0} \)

The subscript 'a' indicates an anterior surface component and the format is the same for both plus and minus lenses.
Boston ES (Enflufocon A) / 7.30 / +0.50 / 9.2 / 8.0 / 8.80@0.4 / 9.80@0.2 / 0.20

- Material = Enflu polymer (USAN prefix), rigid lens, original formulation.
- BOZR = 7.30 mm
- BOZD = 8.00 mm
- \( r_1 \) = 8.80 mm
- SCW = 0.40 mm
- \( r_2 \) = 9.80 mm
- TCW = 0.20 mm
- \( t_c \) = 0.20 mm
- BVP = + 0.50 D
- \( \phi_T \) = 9.20 mm
flattened lens parameters „, how ?

- **BC** : Flatten the base curve.

- **Peripheral curve design** :
  - Because the cornea is flatter in the periphery, flatter peripheral curves have less resistance to movement toward the periphery.
  - Flatter peripheral curves increase axial edge lift and improve lens movement toward the limbus and increase upper lid attachment:
    1. Larger CAEL
    2. Peripheral curves can be flattened or widened.
    3. Steeper BC.

- **minus carrier lenticular** !

- **Lens diameter** : Increase the lens diameter !

  OD Boston ES / 7.40 / +0.50 / 9.6 / 8.0 / 8.90@0.4 / 10.90@0.4 / 0.16
Adaptation or Abnormal Symptoms ?!
Adaptation symptoms distinguished from symptoms because of poor fit in that they decrease until they disappear by time.

Adaptation symptoms:

1. Awareness of the lens

2. Photophobia >> if persist after adaptation period is a symptom of corneal irretability

3. Spectacle blur >> caused by edema

4. Reflections >> from decentered lens

5. Burning sensation
### Terms to avoid and positive terms to use when presenting GP lenses to patients

<table>
<thead>
<tr>
<th>Terms to avoid</th>
<th>Terms to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurt</td>
<td>Initial sensation</td>
</tr>
<tr>
<td>Pain</td>
<td>Edge awareness</td>
</tr>
<tr>
<td>Discomfort</td>
<td>Lid sensation</td>
</tr>
<tr>
<td>Irritation</td>
<td>“Tickling” sensation</td>
</tr>
<tr>
<td>Uncomfortable</td>
<td>Lid awareness</td>
</tr>
<tr>
<td>Painful</td>
<td>“Itchy” sensation</td>
</tr>
</tbody>
</table>
Abnormal symptoms become more severe and more constant as the lenses are worn.

- Symptoms may be caused by poor technique of insertion.
  - The patient may move the eye quickly
  - Or thrust the lens against the lens
  - Or squeeze the lids against the lens

- Symptoms caused by hypoxia >> tight lens
  >> low DK
Abnormal Symptoms:

1. Burning sensation: disappear after removal of the lens
   - tight lens
   - Corneal abrasion
   - 3 and 9 o’clock staining >> dry areas

2. Poor vision:
   - On insertion:
     - incorrect power
     - Wrong eye
     - Poor fit
     - Lens damaged
   - After 2-3 hours >>> corneal edema
3. Excessive awareness of the lens
   - Psychological problem
   - Sudden awareness:
     - Roughened or scratched edge
     - 3 and 9 o’clock staining >> dried secretion on lens
     - Loose lens

4. F.B sensation:
   - In dusty areas
   - Corneal abrasion

5. Blurring of vision at night >> Flare or streaming of lights:
   - BOZD is small
6. Blurring of vision in day time:
   • Lens riding too high
     o High minus power >> thick edge
     o Steep lens
     o Tight upper lid
   • Lens riding too low
     o Heavy high power lens >> plus lens
     o Insufficient edge thickness
     o flat lens
     o Loose eye lid
     o Steep lens !!
   • Decentered lens
7. Spectacle blur :

• Poor tear exchange or low DK >> corneal edema
  >> spectacle blur

8. Blurring during reading :

• Immediately :
  o Lower lid pushes the lens up >> decentered >> poor vision

• Prolonged period :
  o Inadequate blink >> poor tear exchange
Polycon II  7.85 / −2.25 / 9.0 / 7.8

Visual flare symptom at night and indoors but not in daylight

- **Causes:**
  - BOZD is too small
  - Large pupil
  - Or Decentered lens

- **Management ??**
  - BOZD: increased by 0.3 mm
  - Enhance centration: The two simplest changes to improve centration are:
    - Increasing lens diameter by 0.4
    - Steepening the base curve
  - 0.30mm increase in BOZD equivalent to a 0.05mm steepening of the BOZR

Paraperm  7.90 / −2.00 / 9.4 / 8.2
RGP Fitting Assessment
Hallmarks of an optimal RGP lens fit include:

1. Patient comfort
2. Good lens centration
3. Lens–cornea alignment
1. Patient comfort:

Lens comfort is determined principally by the interaction of the lens with the eyelids.

- If either the upper or lower lid hits the lens edge during a blink, lens comfort will be reduced.
- This is of particular importance during the initial adaptation period of 1 to 2 weeks.
Good comfort:

- Upper lid that overlaps the lens and does not hit the edge with each blink is usually comfortable.
  - approximately 1 mm from the lens edge.

- An area of clearance or a gap between the lower lid and lens edge.
  - approximately 1 mm from the lens edge.
2. Good lens centration

• largely determined by :
  
  o BOZR in relation to the keratometric readings,

• Assessment with white light :
  
  o Excursion lag : With the lids in a normal position, the lens periphery should not extend beyond the limbal area even with wide excursions of the eye.
  
  o Static lag : If the lids are held apart and the lens pushed upwards, it should drop slowly. (push-up test)

• Lens movement >> 1-2 mm with each blink
The lens centration is also influenced by a number of other important:

a) Upper and lower lid positions.

b) Tighter lid tension (gauge by difficulty of eversion).
   a) Example is the Asian eye.

c) WTR astigmatism better than ATR astigmatism.
   a) Lens does not decenter laterally.

d) Less lens weight.
   a) Lower power
   b) Thin lenses

e) Large diameter
   • Increase capillary force
   • More lid attachment
f) More posterior center of gravity.
   - Steeper cornea greater than 45 D
   - Minus power
3. Lens–cornea alignment

- Alignment means that the majority of the back surface of the lens is made to align with the cornea so that the weight is distributed over as large an area as possible.

- Alignment must be consistent with good tears interchange behind the lens and with satisfactory vision.

- Central alignment or minimal clearance with peripheral clearance.
Alignment fitting assessment with fluorescein:

- Fluorescein enables a frontal view of the cornea-lens relationship that can be interpreted as a cross-section.
  - Where there are areas of clearance (vaulting), the fluorescein pools under the lens.
  - Where there are areas of bearing (touch), a dark area appears.

- The ideal fluorescein pattern should show three fitting areas:
  - The central area within the OZD (7.00 mm)
    - Alignment or the merest hint of apical clearance.
  - The outer area of the OZD is the midperipheral pattern (about 1.50 mm).
    - Mid-peripheral alignment
  - The area under the peripheral curve system is the peripheral pattern.
    - Edge clearance about 0.5-0.75 mm wide.
Clearance areas become increasingly brighter to a certain thickness!

- After that point, the greater clearance areas do not appear any brighter.
- This leads to the fact that amounts of steepness (clearance) are difficult to quantify.

Areas of darkness are not always areas of touch!

- A dark area within the OZ indicates a tear layer that has fallen below the threshold for fluorescence.
- Dark areas do not necessarily signify that pressure is applied to the cornea.
- The area can have a very thin tear layer, or an alignment relationship.
• Movement and centering should also be noted because the pattern is dynamic.
  
  o Little to no movement usually indicates a steep lens.
  o Excessive movement can indicate a flat lens.

• Two phases can describe lens movement.
  
  o The lens is first pulled up by the upper lid in the rapid phase.
  o The lens drops back into position in the second slower phase.
  o The two phases usually repeat in a cyclical manner with regard to blinking.

• The positioning of the lens will also vary for different phases in the movement cycle.

• Attention should be paid to the movement and positioning upon blink and after (post) blink.
Boston 7 Envision / 7.60 / –7.50 / 9.3

Polycon II 7.85 / –2.25 / 9.0 / 7.8

If TD is not equal to the BOZD?
- peripheral curves
- aspheric design
- monocurve!
  o Carrier

BOZD = 8.00 mm
SCW = 0.4 mm
TCW = 0.2 mm
TD = 9.2
Follow up, adaptation and replacement schedule of RGP lenses
Follow-up visits schedule:

- Contact lens dispensing visit.

- Short-term visit:
  - Following contact lens dispensing at about 1 to 2 weeks.
  - The patient’s adaptation to the new lenses and compliance with instructions are monitored.
  - Changes to lens fit or power may also be made at this time, if indicated.

- Another short-term dispensing/follow-up visit should be scheduled.
• **Medium-term visit**
  - Scheduled 1 to 3 months later.
  - At this point, the patient should be fairly well adapted to the lenses.
  - Should be monitored for any physiologic changes secondary to the contact lens wear.

• **After a successful contact lens wear.**

• **long-term follow-up visits**
  - at intervals of 6 to 12 months.
  - Monitored for abnormal symptoms
Adaptation schedule:

- The patient must adapt to:
  - The lid sensation that the lens edges will impart
  - The cornea to the physiological challenge of the lens,

- So a gradual increase in wearing time is helpful.

- Normally, RGP lens comfort is the worst the first minute after the lenses are inserted.
  - It usually becomes more comfortable from that moment on.

- Removing, rinsing, and reapplying the lenses can enhance wear for the adapting patient.

- New lenses do not wet well, particularly if delivered in a dry state, and storage of the lenses for 24 hours may help.
• Adaptation symptoms are common, particularly in the first one to two weeks of wear for a new patient.

• Typical schedule:

  o The patient is instructed to wear the lens for 2 hours on the first day and add an extra 2 hours a day subsequently.

• Longer schedule:

  o wearing 4 hours the first and second days.

  o Every 2 days, another 1 hour is added until a maximum of 14 hours is reached.
- Shorter schedule:
  - Some experts prefer a much shorter adaptation period of 3 days.
  - In 1st day, 1 hr in the morning, 1 hr afternoon, 1 hr evening. Then increase one hr for each time
  - Or wear in the morning followed by a break in the afternoon and reinserting the lenses in the evening.
  - Patients are expected to reach 6 to 8 hours of wear within the first 2 days.
  - This should be judged on an individual basis.
• First follow-up visit with complaints of sudden onset blurry vision in his right eye only that began 2 days earlier.

• OD  Boston ES 7.67 / –3.25 / 9.2 / 8.0 / 9.20 @ 0.4 / 10.20 @ 0.2 / 0.15  
  OS  Boston ES 7.58 / –2.75 / 9.2 / 8.0 / 9.10 @ 0.4 / 10.10 @ 0.2 / 0.15

• Entering visual acuity with CL:  
  OD  20/40  
  OS  20/20

• Subjective refraction (from previous visit):  
  OD  –3.25 / –1.50 × 180, 20/20  
  OS  –2.75 / –1.50 × 180, 20/20

• Fit assessment:  
  OD  :Centered, blink movement 1 mm, apical clearance, midperipheral bearing, moderate peripheral clearance  
  OS  :Superior temporal, blink movement 2 mm, apical touch, mid-peripheral clearance, moderate peripheral clearance

• The patient has switched the lenses !!

• A dot was placed on the right lens. The patient was educated on lens switches and rescheduled for his next follow-up visit.
Wearing Schedule

1. Daily wear lenses are worn only during waking hours. The average of 8 to 14 hours of lens wear is normal for daily wear lenses.

2. Extended wear lenses are designed to be worn for 3 to 7 days and nights.

3. Continuous wear lenses are worn up to 30 days and nights without removal.

4. Flexible wear (utilized during the day and occasionally overnight).

5. Occasional wear (indicated for occasional use, e.g., athletic or social activities).
How often should gas permeable contact lenses be replaced?

- Lens replacement is highly variable and depends on lens material and patient handling.
  - Guillon et al (1995) found a measurable decrease in surface wettability after 6 months.
  - Woods and Efron (1996) found that planned replacement of the lenses reduced surface scratching, drying and deposition as well as mucous coating.
- Excessive scratches, heavy depositing, or power changes are indications for lens replacement.
- Patient handling may also induce contact lens base curve warpage and/or power changes.
  - If this results in decreased vision or an altered contact lens fit, then the lens should be replaced and the patient should be educated in proper lens handling.
- Over time the lenses become gradually less comfortable and the vision may decline gradually.
- Surface deposition will increase the chances of an immunological reaction.
• Often these changes are nearly imperceptible, and the patient is surprised how well a new lens performs in comparison with the old one.

• With modern materials, repolishing is rarely a practical proposition.
  
  o They are constructed to be as thin as possible to begin with, and some are surface-treated.
  o Over-polishing can render the surface hydrophobic
Replacement schedule:

1. Disposable or planned replacement (discarded after a specified wearing period defined by manufacturer’s guidelines).
   - Can be disposed of daily, weekly, biweekly, monthly, bimonthly, or quarterly.

2. Traditional/conventional: replaced annually.
   - Annual or yearly lens replacement is generally reserved for custom soft lens designs and RGP lenses.
   - A rigid gas permeable lens generally lasts approximately 1 to 2 years,
Symptoms
- Lens discomfort with RGP lenses
- Fluctuating vision

Contact lens parameters:
- OD FluoroPerm 30 / 7.80 (43.25) / –0.75 / 9.2 / 7.6 / 9.30@0.5 /11.00@0.3 / 0.18
- OS FluoroPerm 30 / 7.90 (42.75) / –2.00 / 9.2 / 7.6 / 9.40@0.5 /11.00@0.3 / 0.16

Visual acuity with CL:
- OD 20/20
- OS 20/20

Keratometry (prior to CL fitting):
- OD 44.75 / 43.50 @ 090
- OS 44.50 / 43.00 @ 080

Over-refraction:
- OD +0.25 –0.25 × 180, 20/20
- OS +0.25 –0.25 × 170, 20/20
Biomicroscopy: No abnormalities noted OU

Contact lens fit:
Inferior-temporal position, slow rolling movement on blink, apical touch fluorescein pattern with moderate midperipheral clearance and moderate peripheral clearance OU
Diagnoses??

Flat contact lens on an against-the-rule cornea

Management:

improve the lens-to-cornea alignment

The fit was steepened and stabilized by:

• increasing lens diameter and optic zone or steepen BOZR
• Adding a minus carrier lenticular edge
• Decreasing center thickness

OD FP30 / 7.80 (43.25) / –0.75 / 9.6 / 8.0 / 9.30@0.5 / 11.00 @0.3/ 0.14
OS FP30 / 7.90 (42.75) / –2.00 / 9.6 / 8.0 / 9.40@0.5 / 11.00 @0.3/ 0.12
RGP Contact Lenses in Presbyopia
• Presbyopic contact lens correction has changed dramatically over the past few years.

• New soft and RGP bifocal and multifocal technology has brought these lenses to the forefront of contact lens fitters.

• The number of presbyopes in the United States is approaching 100 million and increasing at the rate of 4 million per year.

• Once the vision-corrected population reaches the age of 50:
  o percentage of contact lens wearers drops to under 5%,
  o only a fraction of those wearing bifocal or multifocal lenses.

• Successful fitting of presbyopic patients relies on:
  o the technical expertise of practitioners,
  o ability to communicate with patients and inform them of the advantages of, and compromises required with, presbyopic contact lens correction.
Patient selection

• Presbyopes may not be aware of the options available to them in contact lenses.

• Many are disturbed at the thought of needing reading glasses or bifocals and are highly motivated to see and be seen without glasses.

• Many entered presbyopia with a strong desire to maintain their appearance of youth and fitness >> motivation

• Unrealistic expectations must be discussed
Before proceeding with the fitting, it is important to discuss the limitations of current lens designs and physiological and optical limitations that may interfere with success:

- including pupil size,
- dry eye syndrome,
- and refractive errors or
- corneal curvatures and other measurements that might be beyond the parameter range.

- health problems, especially those associated with dry eyes, including thyroid disease, arthritis, and other collagen diseases.

- Patients should be questioned about systemic medications that may result in dryness, including:
  - antihistamines,
  - decongestants,
  - diuretics,
  - antispasmodics,
  - hormone replacement therapy,
  - and other psychotropic drugs.
• Their occupational and recreational needs, especially the need for clear vision at the intermediate range for working with computers or reading, should be elicited and discussed.

• Patients should be observed for:
  o hand tremors that might interfere with lens insertion and removal
  o and questioned about diabetes, which might result in changes in refractive status as blood sugar fluctuates, and slow healing of infections or corneal abrasions.
RGP contact lenses in presbyopia

For the presbyopic RGP wearer who wishes to continue with lenses there are a number of options:

1. **Single vision contact lenses** (Contact lenses with spectacle overcorrection)

   - reading glasses to be worn, when needed, over distance contact lenses
   
   - Advantages:
     - popular option with both practitioner and patient.
     - Patients were able to achieve optimum distance acuity with their contact lenses
     - good near vision with the reading overcorrection
     - normal depth perception and stereopsis at near and distance.
     - It is also cost-effective,
2. Monovision

- is defined as the designation of one eye for distance vision and the other eye for near vision.

- Single vision contact lenses are used for each eye.

- The patient selectively suppresses one eye while using the other eye.

- Alternating squinters are ideal, as they are well practiced in suppression of the non-fixating eye.

- this method enjoys higher success rates (50% and 86% ) than multifocal contact lens fitting, but it doesn't suit everyone!
Fitting monovision

- identical to fitting single-vision lenses.
- Both eyes are given the best lenses to maximize visual acuity.
- The near eye is usually the nondominant eye.
- The dominant eye is fitted with a distance lens.
- Emmetropes make excellent monovision patients
- Occupational demands may dictate that the dominant eye be fitted for near. Sometimes, the left eye is chosen for distance. >> the left eye is used for the side-view mirror in the car.

- dominance test:
  - The sighting dominance test
  - The swinging-plus test (+1.50 Ds)
  - near point of convergence the eye that loses fixation first can be chosen as the distance eye.
  - Computer dominance tests
Management of monovision

- may require several follow-up visits.

- Adaptation time
  - is usually 2 weeks,
  - some patients take up to 6 weeks.
  - Normal adaptation includes hazy vision, eye strain, and variable suppression in the first weeks of wear.
  - Adapting patients should be limited to non-demanding visual activities.

- Common fitting problems associated with single-vision lenses (residual cylinder, dry eyes, wrong powers, and poor fit) should be ruled out first whenever there are problems.

- Switching eye function (making the distance eye the near eye and the near eye the distance eye) can relieve even the vaguest symptoms.

- Low add power is sometimes insufficient to enable suppression Increasing the add will be helpful, but it may bring the working reading distance too close.
a. Partial monovision

- Full correction of the near vision may be impractical.

- At a point between 1.00 and 1.50 the eyes crossed over from binocular summation to binocular inhibition.

- When binocular summation is occurring, the binocular contrast sensitivity is about 40% higher than the monocular.

- With binocular inhibition the binocular sensitivity is lower than the monocular.

- However, a high add might help to stabilize blur suppression in some cases, so there may be exceptions to the rule.
b. Enhanced monovision

• A variation on the monovision theme is to fit one eye with a single vision lens and the other with a multifocal.

• Usually this involves a single vision distance lens in the dominant eye and a multifocal in the other.

• The idea is to improve distance vision, usually for driving, while allowing at least casual near vision.

• This may be a useful option for the early presbyope, going over to bilateral bifocal correction later on.
c. **Modified monovision**

- This involves fitting both eyes with a multifocal lens, but biasing one eye more for distance and one eye for near.
- This can be achieved by adjusting the power of the lens.
- Under-correcting the reading addition will bias a lens towards distance vision,
- overplussing the distance correction puts the bias towards near vision.
- Alternatively a different design of multifocal may be used in RGP contact lenses in presbyopia each eye.
Factors that influence success with monovision include:

- Structured, detail-oriented and pessimistic people are less successful than holistic adaptable optimistic ones.

- Patients who report a high level of "ghosting" during a monovision contact lens trial may be poor candidates for monovision.

- Ocular dominance and sighting preference,

- Intercocular suppression of blur,

- Patients for whom monovision fails tend to be older.

- Difficulties with night driving are a major drawback of monovision (glare).

- Compromised stereoacuity is evident with monovision.

- Contrast sensitivity is also reduced.

- Effects of suppression during long-term binocular vision are also potential problems.
3. Multifocal contact lenses

- can be divided into two main categories:
  - alternating vision and simultaneous vision.

a. Alternating Vision

- lenses are required to translate, or move relative to the pupil.
- These are almost invariably RGP lenses
- The advantage to this approach is that all of the light entering the pupil area is focused for the same distance, so the vision should suffer less degradation.
- The downside movement is the skill and time required to fit them well.
• Alternating lenses are generally fitted using the lid-attachment model.

• Photographic evidence suggests that the lower lid accounts for only about 1 mm of the translation. Upper lid attachment accounts for the rest.

• Alternating lenses contain two distinct sectors.

• These may be either fused or solid portions, or extend across the entire width of the lens.

• Segment lenses are more common, but the concept is equally valid with concentric designs.

• Distance and near portions can never be used in the same direction of gaze or at the same time.

• Lens stability and position are controlled by either prism or truncation.
• The lens must move upwards on downward gaze to bring the near portion in front of the pupil area.

• A relatively taut lower lid is necessary; if it is too loose, the lens edge slides across the lower limbus.

• The bottom lid should be no lower than the inferior limbus in order to support the lens.

• There should be minimal disturbance of the lens on blinking or the reading portion is drawn in front of the pupil for distance and the patient complains of variable vision.

• Move from distance portion to near portion can cause image jump!!
• Usually, the segment is monocentric, i.e. the optical centre of the segment is located at the segment top to give 'step-free' vision
- The Presbylite RGP bifocal is a unique translating lens with no-jump optics.

- It contains a spherical distance zone and a wedge-shaped segment with a small aspheric triangular portion containing the intermediate optics at its apex and a spherical near zone that widens out as it approaches the lower edge of the lens.

- Lenses are prism ballasted.

- The sectored near area allows up to 30° rotation without visual disturbance.
• There must be sufficient movement to ensure that approximately three-quarters of the pupil area is covered by the correct section of the lens for both distance and near.
b. Simultaneous Vision

- Usually soft lens multifocal designs are of this type.

- Simultaneous designs essentially provide distance and near vision together and do not rely on lens movement.

- Involve more visual compromise as a significant proportion of the light entering the pupil from the object of regard will not focus in the retinal plane.

- The simplest form of simultaneous lens has concentric zones of distance and near power.

- Most modern lenses have aspheric surfaces, allowing a progressive power function analogous to a varifocal spectacle lens.

- In RGP, Aspheric lenses seem to work by a combination of alternating and simultaneous vision.
• Stability of fit and the ability to discern between distance and near are important factors.

• they are usually referred to as centre near (CN) and centre distance (CD)
Centre near lenses

- Low illumination with CN concentric types favors distance vision because of the increase in pupil size.

- High illumination with CN concentric types favors near vision because of the decrease in pupil size; thus drivers should wear sunglasses.

- With CN aspherics, the larger the pupil the better the distance vision.

- Older patients with small pupils may not achieve good distance acuity.
Centre distance lenses

- Low illumination with CD concentric types favors near vision.
- High illumination with CD concentric types favors distance vision; thus sunglasses should be worn to read on a beach.
- With CD aspherics, small pupils make available less reading addition; thus, the older the patient the less suitable for near.
RGP Contact Lenses in Keratoconus
• Keratoconus may be defined as a progressive, non-inflammatory condition which involves thinning of the central cornea and protrusion and distortion of the cornea into a conical shape.

• The optometrist in general practice may become involved in the diagnosis, fitting and aftercare of keratoconic patients, although most of the care of the more advanced stages is likely to be hospital based.

• Keratoconus is one of the more challenging areas of contact lens practice and there is something of a gray area about most aspects of the disease, but contact lenses form an important part of the management of this condition.
Initial diagnosis

- Keratoconus is often diagnosed in young adults who present for routine refraction

- typically the first sign detected is an increase in astigmatism, and usually myopia, in one or both eyes.

- The condition is bilateral but usually asymmetric.

- the cornea may appear normal unless corneal topography is investigated, and spectacle correction will give satisfactory vision.

- Eventually, the astigmatism will show increase in degree or axis shift and it may be impossible to obtain a visual acuity that satisfies practitioner or patient.
a number of other findings may confirm the diagnosis:

1. Keratometry will give steep readings and the mires may be distorted.

2. Retinoscopy may show a "scissors" reflex.

3. The slit-lamp may reveal Vogt's striae (fine white lines in the deep stroma) as early sign.
4. Later signs include the following:

- Fleischer's ring is a brown or green line encircling the base of the cone (iron-based pigment in the basal epithelium)
• Corneal thinning in the central or paracentral areas. Pachymetry may be helpful if available.
• Munson's sign is a bulging of the lower lid when the patient looks down.

• Central and paracentral scarring occur in severe cases.
There are numerous classification schemes for keratoconus.

- The shape of the cone can be used to classify keratoconus.
- These shapes are evident when the mean K readings are more than 60 D.
- Cone size may increase as the disease advances.
- The larger the cone, the more decentered the apex and the more difficult contact lens fitting becomes.
- The periphery of the cornea is often normal.
- There is a sudden change from cone area to normal periphery in the earlier stages.
1. By Corneal Topography.

Classification by shape is more clearly defined when looking at corneal topographic maps.

- In nipple-shaped topography, there is a central ectasia of less than 5 mm in diameter that is surrounded by almost 360 degrees of normal cornea.
  - Nipple cones are often located centrally or decentered slightly inferiorly.
  - The apex is in the lower nasal cornea, averaging 1.1 mm from the visual axis.
  - Average K readings are greater than 65 D.
  - There is a rapid change between the central ectasia and flatter midperiphery.
• Oval-shaped topography occurs below the corneal midline.
  o Above the midline is an island of normal cornea.
  o Oval cones are larger, and the apex lies in the midperipheral inferotemporal area of the cornea.
  o The apex averages 2.3 mm from the visual axis.
  o Average K readings are greater than 68 D.
• A globus-shaped topography involves almost 75% of the corneal surface, and there are no islands of normal cornea.

  o Globus cones are the largest cones; they are located inferiorly and are larger than 6 mm.

  o True Keratoglobus is a rare bilateral disease where the entire cornea is uniformly thinned.
2. Keratometry readings have been used for classification.

- mild keratoconus is below 45 to 48 D.
- Moderate keratoconus ranges from 45 to 54 D,
- advanced keratoconus is above 52–54 D.
- Severe keratoconus is above 62 D.
Management of keratoconus

The management of keratoconus depends on its severity:

1. Spectacle correction may give a surprisingly good level of vision in early cases, and the wise practitioner is not in too much of a hurry to get the patient into contact lenses.

2. Soft toric lenses are rarely fitted, but in early cases may provide adequate vision.

- Both this option and spectacle correction avoid the increased risk of corneal scarring that RGP lenses may bring.
3. RGP lenses are the most common management strategy for more advanced keratoconus.
   - The tear film behind a rigid lens is capable of correcting some 90% of corneal astigmatism, be it regular or irregular.

4. Scleral lenses used to be the first choice for keratoconus but are now generally only used when RGP lenses cannot provide adequate correction.

5. "Piggyback" lenses consist of a rigid lens fitted on top of a soft carrier lens.
   - They may be useful on very irregular corneas where conventional lenses fail to center, but oxygen transmission decreased.

6. Hybrid lenses consist of an RGP center surrounded by a soft lens skirt, which can aid centration in some cases.
RGP lenses for keratoconus

- The fitting of patients with early keratoconus is likely to be similar to that for any astigmatic patient.

- but once the condition advances >> corneal topography >> more specialized lenses.

- in the hope of controlling disease progression >> lenses were fitted with central bearing

- this approach is controversial!! >> that this type of fit may initiate or exacerbate corneal scarring.

- so the desired goal now is to eliminate central bearing by fitting lenses with apical clearance.
• This is more easily arranged in early keratoconus but in many cases it is impossible to achieve.

• Alternatively, mid-peripheral bearing may relieve some of the pressure on the apex of the cone.

• divided support Or "three-point touch," central bearing with two mid-peripheral points roughly 180° from each other, also bearing some of the weight.

• Mid-peripheral bearing may be impractical with the globus form of cone, and here large flat lenses may be the only option.

• There are many designs available.
objectives of a good RGP contact lens fit in keratoconus.

• achieve a lens-to-cornea fitting relationship with minimal apical touch or slight apical clearance.

• peripheral curve system that permits good circulation of the tear film under the lens but without excessive edge lift.

• Ideally, the lens fit should exhibit:
  
  o Minimal apical touch or apical clearance
  o No excessive areas of tear or debris pooling beneath the optic zone
  o Good circulation of the tear film under the lens
  o Good stability and comfort

• With these conditions, the lens will cause the least amount of insult to the cornea.

• Maximum visual outcome
Fitting protocol

• the more accurate information you have >> the quicker you arrive to a satisfactory outcome.

• A current and accurate spectacle Rx is essential >> do it yourself, even if the last refraction was recent.

• Keratoconics are difficult to refract accurately and somewhat variable.

• A topographical map is highly desirable to give an indication of the type of cone the patient has.
• Topographers often come with bundled software that can take the corneal data and custom design a lens for that cornea, often featuring simulated fluorescein patterns, or at least suggest a suitable trial lens to insert.

• In the absence of such sophisticated technology >> fitting sets
• The TD and BOZD are selected by measuring the average pupil diameter and adding 1-2 mm, while ensuring that the optic zone fully covers the cone.

• The BOZR is based on keratometry >> average K

• However, some practitioners advocate going rather steeper, aiming to insert an initial lens with apical clearance.

• By analyzing the fluorescein pattern, the BOZR can then be progressively flattened until apical touch is seen, and the final BOZR selected according to fitting philosophy.

• A drop of anesthetic inserted into the eye may help to avoid excessive tearing >> make the fluorescein pattern difficult to interpret.

• It is worth giving a keratoconic patient half an hour or so for the lens to settle.
The Soper lens design

• The Soper lens design simulates a hat on the cornea.

• The goal is to achieve a slight apical clearance fitting relationship.

• The Soper Cone system uses bicurve lenses

• used when there is already significant protrusion of the cone occupying a large area of the cornea.

• the fitting philosophy is based on sagittal depth, using a combination of BOZR and BOZD.

• The fitting set consists of 10 lenses subdivided into "mild" (7.40 mm To 6.00 mm BOZD) "moderate" (8.50 mm To 7.00 mm BOZD) and "advanced" (9.50 mm To 8.00 mm BOZD) subsets.

• The aim is to avoid apical touch

• but the bicurve construction may provide inadequate peripheral clearance which may cause the lens to seal off tear exchange.
The McGuire lens design

• This system was a development of the Soper design.

• It also has three diagnostic sets which are formulated for the different forms of cone.

• The "nipple" set has a BOZD of 6 mm, the "oval" one of 6.5 mm and the "globus" 7 mm.

• The lenses have three or four peripheral curves.

• The aim with this set is to achieve three-point touch.

• The McGuire lens design is often prescribed for oval and more advanced cones.
Rose K design

- The Rose K lens is fitted with a 2.0 to 4.0 mm area of light apical touch with attention paid to achieving optimal peripheral clearance.

- A proprietary diagnostic lens set is available in base curves ranging from 5.10 to 7.60 mm in 0.10-mm increments.

- The fitting guide recommends selecting the initial base curve 0.2 mm steeper than the average keratometry values.

- The standard overall diameter is 8.7 mm, and the optic zone decreases in diameter with steeper base curves.

- has complex, computer-generated peripheral curves.
• standard edge lift >> after observation of the fluorescein pattern combinations can be selected which are 1.00, 1.50, 2.00, 2.50 or 3.00 mm flatter and 0.50 or 1.00 mm steeper than standard.

• BOZRs range from 4.75 to 8.00 and TDs from 7.90 to 10.20, and both front and back surface toricities are available.

• Again, three-point touch is the aim with edge clearance 0.80 mm wide
Rose K2 design

- Essentially the same design as the original Rose K but with spherical aberration control over the back optic zone diameter.

- This gives an improvement in vision for the high minus powers necessary with very steep radii but might occasionally give a tighter fitting.
RGP Contact Lenses for High Myopia and Aphakia
High myopia:

- Contact lenses give cosmetic enhancement

- contact lens rests on the eye and thus give larger retinal image and more normal than it would be by spectacle.

- the visual field is also not restricted by the edge of the glasses.

- High myopia (-6.00 or greater) contact lenses has extra thick edges creates a base up wedge effect.

- causes the lens to be pulled up by the upper lid and consequently to ride high so that the patient fails to look through the center of the lens.

- To reduce the thickness of the edge must be shaved off to prevent the upper lid from tugging up ward on the lens

- this in effect result in a lenticular design lens for high minus power.

- The higher the minus power, the more the anterior edge has to be reduced.
(a) and (b) show curves with a marked point $C$. The curve on the right is labeled "Positive border."
Aphakia:

- Aphakia individual require strong plus lenses.
- as the power of the plus lens increases, so does the central thickness of the contact lens.
- This increase in central thickness creates a base-down wedge effect at the upper edge of the lens, and thus the upper lid forces the lens downward,
- the high plus lens is also heavy which cause it to gravitate downward.
- Aphakic contact lenses can be designed with a single cut design or a lenticular design.
- The single cut contact lens has a more curved anterior surface and an anteriorly displaced center of gravity, which may cause the lens to displace inferiorly.
- Single cut rigid contact lenses should be attempted only when lenticular contact lenses do not work.
• A contact lens with a lenticular design has a flatter anterior curvature and a peripheral flange to facilitate better lens centration.

• The most commonly used design is the lenticular design with a minus carrier.

• The minus carrier facilitates lid attachment, which centers the contact lens better.

• Lenticular contact lenses can be used for all aphakic patients, but they are particularly indicated for corneas flatter than 43.00 D.
• The base curve of the contact lens is selected based on the keratometry readings of the cornea.

• The power of the contact lens should be determined by performing an overrefraction with a trial lens power close to the patient’s refraction.

• If the power > 4 D, take into account the vertex distance.

• The choice of a final contact lens should be based on the centration, movement, fluorescein pattern of the contact lens, as well as the vision and ocular health of the eye.

<table>
<thead>
<tr>
<th>Corneal toricity</th>
<th>Base curve*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spherical</td>
<td>0.50 D flatter than flat keratometry reading</td>
</tr>
<tr>
<td>0.12–0.62 D</td>
<td>0.25 D flatter than flat keratometry reading</td>
</tr>
<tr>
<td>0.75–1.37 D</td>
<td>Same as flat keratometry reading</td>
</tr>
<tr>
<td>1.50 D or more</td>
<td>Flat keratometry reading + (1/3 times difference between steep and flat keratometry reading)</td>
</tr>
</tbody>
</table>

*Final base curves may be slightly steeper than indicated by this table in order to improve stability of the contact lens on the eye.
Orthokeratology
• Orthokeratology is a process in which rigid contact lenses are used to induce changes in corneal curvature, thereby modifying refractive error.

• The cornea is easily deformed by external Pressure.

• RGP contact lenses regularly produced changes in corneal curvature and refractive error but this was generally seen as a side-effect, and not a particularly desirable one.

• In 1962, Jessen suggested that these changes could be used deliberately to modify refractive error.

• Practitioners attempted to put this idea into practice but results were variable.

• Orthokeratology has continued to be a minority interest, but a number of developments have re-stimulated interest in recent years.
• Possibly the most significant development has been the emergence of videokeratography, allowing detailed topographical analysis of the whole cornea.

• Lenses can be designed more precisely for individual corneas and induced changes observed in much greater detail.

• Orthokeratology took a large step forward with the introduction of reverse geometry lenses.

• Early orthokeratology lenses tended to be large and flat, and they often didn't center well.

• This in turn could lead to induced astigmatism, the opposite effect to the one expected.

• Reverse geometry lenses have a flat central base curve with a steeper secondary curve.

• These lenses can achieve more rapid change than the old designs, so use of them is sometimes termed "accelerated orthokeratology."
• There is some evidence that reverse geometry lenses do a little more than simple flattening of the central cornea.

• Swarbrick et al (1998) found a number of changes:
  o Flattening of the central cornea.
  o Central corneal thinning, probably mostly epithelial.
  o Mid-peripheral corneal thickening, mostly stromal.

• The results suggest that orthokeratology is not just a simple process of bending the cornea.

• Tissue redistribution may also be taking place, possibly in response to the pressure exerted by the tear reservoir under the lens.
Will it work?

• The effects of the earlier designs were varied.

• Some practitioners claimed to have corrected 4-5.00D of myopia but most claimed considerably less.

• More recent studies using reverse geometry lenses seem corrected 1.50D ± 0.50D and about half of the corneal astigmatism is eliminated.

• There is significant individual variability.

• High myopes tend to change less than those with mid-range prescriptions.
• It is claimed that corneal asphericity is an important determinant of success.

• Most corneas flatten towards the periphery and are said to have a positive shape factor.

• During orthokeratology, the cornea flattens more centrally than peripherally, to the point where the shape factor is effectively zero and the cornea more or less spherical.

• videokeratography an essential tool for this type of practice.

Regression

• The induced changes in corneal curvature are not permanent.

• As soon as contact lens wear is suspended the corneal change, and thus the refractive error, begins to regress.

• The rate of regression varies but the typical value is 0.50Dper day.

• In order to sustain the new refractive status some wearing of contact lenses is essential.

• These "retainer" or "sleeper" lenses may be worn during the day or overnight.
Night therapy

- The availability of high-transmission materials has made it possible to wear the orthokeratology lenses overnight and remove them for the day.

- Patients whose occupations require a specified level of unaided vision may find this option useful, as may the terminally vain.

- The design of reverse geometry lenses may contribute towards a tendency to adhere to the cornea, and lenses are now being designed to fit a little looser in an attempt to overcome this problem.
Is it safe?

• On the evidence so far there seems to be no greater risk with modern orthokeratology lenses than with conventional RGP lenses in a similar wearing modality.

• Complications do occur, but only at the same rate and of the same type as those of RGP wearers generally.

• The long-term effects of central epithelial thinning remain to be seen.
RGP Contact Lenses Evaluation and Inspection
• Contact lens practitioner should accept only high quality lenses.

• Lenses arriving from the laboratory should be verified that they have been made to exact specification.

• In addition adequate evaluation of the lens dimension will eliminate frustration in fitting that might be attributed to faulty lens construction.
Diameter:

- The first parameter to be checked is the diameter of the lens.
- The diameter of rigid lenses can be assessed with:
  1. V gauge (v-shaped groove with scale).
  2. measure hand magnifier.
3. Shadow scope:

- Shadow scope magnifies contact lens in cross section or in front view.

- Magnification of the contact lens to 20 times, its size is accomplished by internal projection on a ground-glass screen.

- On the screen is a reticule scale graduated in 0.1 mm, which can be used to measure:
  - diameter of the lens.
  - the width of the peripheral curve.
  - the width of any blending area.
  - the width of the intermediate curve.

- The blending zone cannot be seen by the naked eye, but can be evaluated only under the large magnification created by the shadow scope.
• The shadow scope is also useful in showing scratches on the optical surface of the contact lens as well as any crakes or nicks in the edge.

• The cross-sectional view of the contact lens shows up the contour of the edge, so the edge thickness can be measured.
Base curve:

1. Optic spherometer (RADIUSCOPE) or contacto gauge:
   - Measure the base curve of a lens and also to detect possible warpage of a lens that would be responsible for improper fitting.
   - The radiuscope is designed to accurately measure the radius of curvature of the anterior and posterior surfaces of rigid contact lenses.
   - All the commonly available radiuscopes operate using procedures similar to the following:
     - A drop of water is placed on the lens mount upon which a contact lens is floated convex side down.
     - A spot of light is centered in the middle of the lens and the body of the microscope is raised as high as it will go.
The microscope is then focused downward until a spoke pattern, the first of three images, comes clearly into view.

This is called the aerial image and represents the reflection from the posterior surface of the lens.

Once the aerial image becomes sharply focused a pointer is set to zero on the scale.
- Continue to move the body of the microscope downward.

- On the way to its final location, an image of the bulb filament will come into view.
Continue beyond this image. Eventually, another spoke pattern will come into focus.

This represents the level of the lens surface, so it is possible to observe surface details at this point.

Focus this third image as sharply as possible. The reading on the scale now represents the radius of curvature of the lens surface in millimeters.
o It is generally advisable to double check the final reading.

o This can be accomplished by focusing the microscope all the way up to the original aerial image.

o At this point the pointer should once again be on zero. If not, reset it at zero and repeat the entire process.
○ Toric Curves:

- Toric curves are somewhat more complex to interpret than spherical curves, although the technique employed is the same.

- Since a toric surface contains two separate radii of curvature not all the spokes in the pattern will be in focus simultaneously.

- Taking an accurate reading, therefore is a matter of making two separate measurements for each lens surface.
Power:

- Measured by lensmeter.
- By holding the lens between the thumb and forefinger, concave side down, the examiner can measure the back vertex power of contact lens.
- Small error in power will arise which is significant error in high plus power lens.
Measuring thickness:

- C.L is inserted in the thickness gauge, convex side down.
- The pin of the gauge is allowed to descend slowly until touch the concave surface of C.L. The measure is read from the dial.
Profile analyzer:

- Proper evaluation of the peripheral curves and the blend at the junction is probably the most important feature of evaluation of a contact lens.

- The profile analyzer is an instrument designed to show the profile of contact lens and is invaluable in any office where contact lens work is performed.

- It will detect whether the zones between the central and peripheral curve are sharp or whether they have been blended and smoothed out, thereby adding to proper venting and comfort of the lens.