Rigid gas permeable fitting system

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Abstract
The intent of this paper is to introduce a simplistic model for fitting rigid gas permeable lenses. It is designed to be utilized as a starting point for clinicians with limited RGP fitting experience. Discussion will be centered on determining parameters of the lens to order and a specific fitting plan. Also included are RGP fluorescein patterns and a cookbook method for fitting bitoric RGP lenses.

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RIGID GAS PERMEABLE FITTING SYSTEM

BY

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JOHN RIPLEY

A thesis submitted to the faculty of the
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ABSTRACT: The intent of this paper is to introduce a simplistic model for fitting rigid gas permeable lenses. It is designed to be utilized as a starting point for clinicians with limited RGP fitting experience. Discussion will be centered on determining parameters of the lens to order and a specific fitting plan. Also included are RGP fluorescein patterns and a cookbook method for fitting bitoric RGP lenses.
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We would like to dedicate this paper to two individuals who through example acted as role models for us to pattern our futures. Our greatest appreciation to Bull Shannon and Oliver North.

The Authors
In all fitting philosophies keratometry measurements are used as the starting point from which the base curves of the prospective lenses are selected. Therefore, proper calibration of the keratometer is a necessity. Typical calibration consists of taking keratometer readings on the individual patient, then performing keratometry on calibration balls of similar radius and correcting the patients keratometry readings for any disparity between the two findings. For example, if the patients keratometry reading is 46.0 and measurements taken on a calibration ball with radius corresponding to 46.0 is 46.5 the patients reading must be corrected to 45.5. Once accurate keratometry readings are obtained the base curve of the lens is chosen. Choice of base curve is usually a function of the flattest keratometer measurement ($K_f$). When a lens is fit steeper than $K_f$ the fit is called apical clearance and when fit flatter than $K_f$ it is called apical touch.

Fitting philosophies vary among practitioners but it is generally agreed that apical touch is undesirable, leading to epithelial damage and possible scarring.\textsuperscript{1} On the other hand excessive apical clearance can lead to mid-peripheral bearing and 360 degree seal-off which limits tear exchange from under the lens to outside the lens.\textsuperscript{2} With these two detrimental characteristics of base curve selection in mind, it is agreed by many clinicians that an apical alignment or slight apical clearance is the ultimate goal in base curve selection.

Base curve selection is not determined solely by keratometer readings but also by the overall diameter of the lens. The human cornea is aspheric, being steeper (of greater curvature) centrally and flatter.
peripherally. RGP lenses are spherical. With this in mind, if a 8.0 overall diameter lens fit for alignment is increased to 9.0 with the same base curve it will be too steep resulting in apical clearance caused by the peripheral lens riding on flatter corneal regions. As a general rule the smaller the overall diameter the steeper the base curve necessary for fitting a specific cornea. Factors which affect overall diameter selection include interpalpebral fissure size, lid tension, and pinguecula\pterygia, corneal toricity and pupil size.1,2

High amounts of corneal toricity may necessitate altering the base curve or overall diameter. Moderate amounts of corneal toricity require a steeper base curve with respect to \( K_f \). This steepening is done to split the difference between the two radii of different curvature thereby decreasing the severity of the apical touch or apical clearance. Larger overall diameter may also allow the bearing surface of the lens to rest on more peripheral regions of the cornea where the corneal toricity may not be as great. High amounts of corneal toricity (2.0 and up) will most likely require a RGP bitoric fit or soft toric fit.

RGP lens parameters may need to be altered to rectify lens decenteration.1 Lenses decentered superiorly can be centered by applying an anterior bevel thus decreasing superior lid adherence allowing the lens to drop. Other solutions for superior riding lenses include; flattening or blending peripheral curves, decreasing overall optical zone diameter, or steepening the base curve radius. Inferior riding lens may result from loose lids, lens mass, and corneal topography. Methods of centering inferior riding lenses include; minus carrier lenticular configuration on plus lenses, decreasing overall diameter, or steepening the base curve.
radius. Laterally displaced lenses are usually the result of a displaced corneal apex. Increasing the optic zone diameter so as to achieve adequate pupil coverage is the best solution.

Keratometer readings and overall diameter choice allow for a preliminary base curve selection for trial lens fitting. The final base curve selection, however, is determined by observing the fluorescein pattern for centration and alignment.

Instillation of fluorescein and use of the cobalt blue light and wratten #12 filter allows for best assessment of the cornea\lens interface. Fluorescein patterns may take a variety of diagnostic forms. Heavy central pooling with areas of peripheral bearing indicate apical clearance and that a flatter or smaller lens of the same base curve is needed for an optimal fit. Lack of fluorescein centrally indicates apical touch, a steeper lens or larger lens of the same base curve is indicated in this case. A light fluorescein pattern between the majority of the cornea\lens interface indicates an alignment fit which is seen by many clinicians as being an optimal fit. A dumbell shaped area absent of fluorescein is seen with many corneas with corneal toricity greater than 1D\textsuperscript{1} with the dumbell oriented horizontally for WTR corneas and vertically in the case of ATR corneas. To minimize this type of bearing steepening of the base curve is indicated, however too much steepening will result in unfavorable physiologic corneal changes. It becomes apparent that if a spherical RGP is to be used in cases of moderate corneal toricity a balance must be reached between excessive lens bearing and the use of an excessively steep lens. When an appropriate balance can not be found a bitoric RGP may be the answer. Peripheral curve evaluation by fluorescein
becomes more important when the ordered lens is fit, but can also be of some usefulness with the diagnostic fit. Adequate peripheral curves occupy approximately 30% of the lens area and feather gently into the optic zone. If the radii and width of the peripheral curves of the diagnostic lens are known, specific peripheral curve characteristics may be ordered to obtain optimal peripheral curve fit. For example, if the diagnostic lens peripheral curves occupy 15% of the lens and there is a sharp junction between peripheral curves and the optic zone then the final lens may be ordered with a wider peripheral curve and heavier blend.

Center thickness is another variable that must be accounted for when ordering an RGP lens. When the corneal toricity is minimal, center thickness considerations are not as important as when the corneal toricity is moderate to high. With moderate to high corneal toricity flexure of the lens upon blinking changes the optics of the lacrimal lens and the contact lens itself. In affect the peripheral tear lens becomes thinner causing a decrease in minus power, or put another way, there is a representation of corneal astigmatism upon blinking that was previously masked by the spherical lens. An increase in center thickness will decrease lens flexure thereby decreasing blur caused by blinking. The amount of lens flexure can be estimated by noting distortion of the keratometer mires following a blink while the patient is wearing the lens. If significant, a increased center thickness is indicated.
SPECIFIC FITTING SYSTEM

1) Base curve
   a) If the corneal toricity = 0 select base curve .25 flatter than $K_f$.
      This allows the lens to rock slightly on the cornea while an alignment
      or slightly steep fit would cause seal-off.
   b) If corneal toricity is .25-.75 fit .25 steeper than $K_f$.
   c) If corneal toricity is 1.00-2.00 fit .50-1.00 steeper than $K_f$.
   d) If corneal toricity is > 2.00 a bitoric would most likely be the
      best solution.
      This base curve selection is based on an overall diameter of 9.0-9.2.
      If a 9.5 is used, start slightly flatter for each example.

2) Peripheral curves
   a) Tricurve: typical peripheral curve selection base curve radius
      + 1.0 to 1.5mm/.4 IC with a base curve radius +2.5 to 3.0/.3 PC.
      Radius of peripheral curves may change depending on base curve.
      Examples:
      8.23 base curve- 9.5/.4 IC, 11.0/.3 PC
      7.85 base curve- 9.0/.4 IC, 11.0/.3 PC
      7.34 base curve- 8.5/.4 IC, 10.5/.3 PC
      These curves will typically be steep because it is easy to flatten
      a curve but impossible to steepen one.

3) Center thickness
   a) Use standard thickness if corneal toricity < 1.00.
   b) If corneal toricity is >1.00 than add .02mm to standard thickness
      for every .50 change in corneal toricity over 1.00.
BITORIC LENS FITTING GUIDE

For patients whose corneal toricity does not allow a comfortable fit, bitoric lenses may be the answer. Trial fitting bitoric RGP’s is uncommon. Attached is a worksheet that allows bitoric fit computation from keratometer readings and the spectacle Rx. The form consists of 5 simple steps.

1) Enter $K_f$ and $K_s$.

2) Enter spectacle power
   a) sphere in the left column
   b) sphere + cyl combination with appropriate sign in the right column

3) If either the sphere or the sphere + cyl is greater than 4.00D correct for vertex using chart at the bottom of the form.

4) Enter fit factor with appropriate +/- sign.
   a) $K_f$ is always fit .25 flatter inducing a -0.25 lacrimal lens in that meridian. Therefore, +0.25 must be added to the power in that meridian.
   b) $K_s$ is always fit flat, but the amount increases as the change in corneal toricity increases. The same theory exists as with $K_f$; fitting flat induces extra minus power (caused by the lacrimal lens) which must be compensated for by adding + power to the sphere + cyl meridian.

5) Final base curve and power.
   a) Add lines 1 and 4 for final base curve for each meridian.
   b) Add lines 3 and 4 for final power for each meridian.
**Keratometry**

**Spectacle Rx (Minus Cyl Form)**

1) **Enter K**

2) **Enter Spectacle Pwr**

3) **Vertex Corrected**

4) **Fit Factor**

   - Add Lines

5) **Final C.L. Rx**

**Left Eye**

<table>
<thead>
<tr>
<th>Vertex Distance Correction</th>
<th>Corneal Cylinder</th>
<th>Flat Merid.</th>
<th>Steep Merid.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00 3.75</td>
<td>2.0 diop</td>
<td>.25 Flatter</td>
<td>.50 Flatter</td>
</tr>
<tr>
<td>4.25 4.00</td>
<td>2.5 &quot;</td>
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<td>4.50 4.25</td>
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<td>5.00 4.75</td>
<td>4.0 &quot;</td>
<td>.25 &quot;</td>
<td>1.00 &quot;</td>
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<tr>
<td>5.50 5.25</td>
<td>5.0 &quot;</td>
<td>.25 &quot;</td>
<td>1.25 &quot;</td>
</tr>
</tbody>
</table>

If the spectacle lens power is less than 4.00 diopters then line 3 = line 2. Otherwise: For minus power spectacle lenses find the power in the left side of the column and convert to the power in the right side, but retain the minus sign. For plus power spectacle lenses find the power in the right side of the column and convert to the power in the left side, but retain the plus sign.
FLUORESCIN PATTERNS: Keratometer measurements are useful in selecting a preliminary trial lens fit but since corneas are rarely of regular curvature, base curve radius selection by way of keratometer findings may not always be adequate. Fluorescein patterns are the best method of evaluating the true cornea/contact lens interface. Fluorescein patterns of several different RGP lenses are provided at the conclusion of this paper. Picture one represents a steep fit. Telltale characteristics of a steep fit include heavy central pooling, accumulation of bubbles centrally, and peripheral bearing which presents as peripheral regions absent of fluorescein. Also worth mentioning is the poor edge clearance denoted by the sharp junction between the outside edge and the cornea. Picture two is of a flat fit that has dropped to the lower limbus. This lens exhibits bearing in the pupillary region with pooling in the inferior peripheral area. Although flat lenses generally show apical touch, the apical touch in this picture is secondary to a low riding lens. Picture three represents a steep fit with moderate central pooling and mid peripheral regions with small amounts of fluorescein indicating apical clearance and mid peripheral bearing. Although the junction between the peripheral curves and optic zone is not abrupt and feathers gently into optic zone indicating an adequate blend, the midperipheral bearing should be decreased by using a flatter curve in that portion of the lens. Picture four shows a slightly steep lens with minimal areas of mid peripheral bearing nasally. The temporal edge shows tight peripheral curves with little blend. Number four represents an acceptable fit as far as fluorescein pattern evaluation. However, the final lens should be ordered with a flatter peripheral curve and heavier blend.
REFERENCES


2. Nada Lingel, O.D. Professor of Optometry, Pacific University College of Optometry. Forest Grove, Or.