Fitting the bitoric rigid gas permeable contact lenses on high corneal astigmats

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Abstract
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FITTING BITORIC RIGID GAS PERMEABLE CONTACT LENSES ON HIGH CORNEAL ASTIGMATS

BY

CARLA AVRUSKIN
TRACIE VU

A THESIS SUBMITTED TO THE FACULTY OF THE COLLEGE OF OPTOMETRY
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FOREST GROVE, OR
FOR THE DEGREE OF
DOCTOR OF OPTOMETRY
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ADVISOR: JENNIFER SMYTHE, O.D.
CARLA AVRUSKIN

Carla Avruskin was born in Massachusetts and grew up on Long Island, New York. Her parents live in New York, and she has a sister in southern California, and a sister and brother-in-law in Minnesota. Ms. Avruskin graduated from Drew University in New Jersey with a B.A. in biology, and will graduate from Pacific University College of Optometry in Oregon with an O.D. in May of 1996. She plans to practice in the northwest United States.

TRACIE VU

Tracie Vu grew up in Portland, Oregon. She completed her high school education at Benson Polytechnic in 1987. Ms. Vu graduated from Oregon State University in 1991 with a B.S. in microbiology, and will graduate from Pacific University College of Optometry with an O.D. in May of 1996. She plans to practice in Portland, Oregon.
Fitting Bitoric Rigid Gas Permeable Contact Lenses On High Corneal Astigmats

(15 sec) (music)

Rigid Gas Permeable (RGP) Contact Lenses

- Increased Oxygen Permeability
- Excellent Vision
- Durability

Rigid gas permeable contact lenses, or RGP’s, offer superior oxygen permeability, crisp vision, and improved durability over soft contact lenses. (15 sec)

RGP Lens Designs

- Spherical
- Aspheric
- Bitoric

RGP’s are available in spherical, aspheric, and bitoric designs to maximize the lens to cornea fitting relationship. Spherical lenses are best for corneas with less than 2 diopters of astigmatism. Aspheric lenses can enhance the fit for corneas with less than 2.5 diopters of astigmatism. (30 sec)

Spherical RGP On High Corneal Astigmat

- Poor corneal alignment
- Decentration
- Poor tear exchange

Yet spherical lenses on a cornea of greater than 2.5 diopters of astigmatism may result in poor corneal alignment, decentration, and
poor tear exchange. The outcome is a poor fit with decreased vision. (20 sec)

BITORIC RGP
ON HIGH CORNEAL ASTIGMAT

- Good corneal alignment
- Improved centration
- Increased tear exchange

Bitoric lenses improve the lens to cornea fitting relationship on corneas of greater than 2.5 diopters of astigmatism. (20 sec)

RGP PARAMETERS

- Base Curve
- Diameter
- Toricity

Parameters affecting the fit of bitoric RGP's are base curve, diameter, and toricity, which is the difference between the two base curves of the lens. This video will show how fit is affected by varying RGP parameters. Lenses of different parameters will be shown on the same eye throughout the video, so that each fit may be compared directly to the others. (30 sec)

EMPIRICAL FITTING:
Keratometry and Refraction
DIAGNOSTIC FITTING:
Diagnostic Trial Lenses

There are 2 ways of properly fitting RGP's: empirical and diagnostic. Empirical fitting involves calculations using keratometry readings and refraction. Diagnostic fitting involves assessing diagnostic trial lens fits. (20 sec)

EMPIRICALLY CALCULATING BITORIC RGP FIT

(10 sec)
BITORIC RGP FITTING
-9.0 mm OAD
-On Kf
-1.0 D “Rocking Room”

There are many ways of empirically fitting bitoric RGP’s. One of the more popular methods is to select a 9.0 mm overall diameter and fit on K flat, which is the flattest corneal meridian. It is necessary to under correct corneal toricity by about 1 diopter for sufficient tear exchange. This is called rocking room. (35 sec)

FITTING A 3.0 DIOPTER WTR CORNEAL ASTIGMAT

This video will show bitoric lens fitting of a 3 diopter with the rule corneal astigmat. (10 sec)

(mastervue topography)

The patient is a 26 year old white female with no ocular pathology. Only the right eye will be shown. The Mastervue corneal topography calculates central keratometry values with a K flat of 45 diopters at 18 degrees and a K steep of 48 diopters at 108 degrees, exhibiting 3 diopters of with the rule corneal astigmatism. Gravity coupled with the 18 degree axis orientation will allow RGP lenses to drift temporally along this flattest meridian, affecting lens centration and edge relationship. (50 sec)

EMPIRICAL CALCULATION OF BITORIC RGP FIT

The empirical calculation of lens fit for this patient relies on keratometry and refraction. (10 sec)

CALCULATION OF RESIDUAL ASTIGMATISM WITH RGP FIT

(10 sec)
Equation for Residual Astigmatism:
Refraction Correction
- Keratometry Reading
Residual Astigmatism

Residual astigmatism can be predicted to determine the RGP lens design needed for clear vision. A popular way of calculating residual astigmatism is to numerically subtract keratometry values from refraction values. (25 sec)

OD Keratometry:
45.00@180, 48.00@090
Represents:
PL-3.00x180

For example, our patient's right eye keratometry values are 45 diopters at approximately 180 degrees, and 48 diopters at approximately 90 degrees. This represents a relationship of PL-3.00x180. (17 sec)

OD Spectacle Rx:
-6.50-3.00x180
Vertex Distance Correction:
-6.00-2.50x180

Our patient's spectacle correction is -6.50-3.00x180. After correcting for a 12 mm vertex distance, the refraction becomes -6.00-2.50x180. (20 sec)

Residual Astigmatism:
-6.00-2.50x180
- PL-3.00x180
-6.00+0.50x180
or -5.50-0.50x090

These values are placed into the equation for residual astigmatism. Keratometry cylinder is subtracted from refractive correction. The axes must be matching. For example, if keratometry values were at axis 90, these readings would have to be converted into plus cylinder format so that the axis would read 180. Here, Pl taken from -6 is -6 sphere. -3 cyl subtracted from -2.50 is +0.50 cyl. The residual astigmatism is +0.50x180. Conversion to minus cylinder format results in -5.50-0.50x090. This is a minimal amount of residual astigmatism. Therefore,
a spherical power effect, or SPE, bitoric RGP will be sufficient for clear vision. (1 min 25 sec)

Fitting
The
3.0 Diopter
WTR Corneal Astigmat

In this video the emphasis will be on assessing the fit of the lenses. Refractive correction will not be discussed further. (10 sec)

(naked eye)
CORNEA: 3.0 D WTR

Here is our patient’s right eye with no contact lens to show lid configuration and blinking patterns. Note the patient has full complete blinks. With time, epithelial staining may be evident, as all video footage was shot in one sitting.

Spherical Lens
On 3.0 Diopter
WTR Cornea

(10 sec)

(cl shot)
CORNEA: 3.0 D WTR
LENS FIT: ON Kf
OAD: 9.0 mm

This is a spherical RGP lens on our patient’s 3 diopter with the rule cornea. The lens is fit on Kf, with a diameter of 9.0. Note the classic dumbbell Fl pattern, which indicates apical bearing and 12 and 6 oclock pooling where the cornea is steepest. The lens dropping indicates inadequate fit.

Empirical Optimal Lens

(10 sec)
CORNEA: 3.0 D WTR
LENS FIT: -On Kf
   -2.0 D Toricity
   -9.0 mm OAD

The empirical optimal bitoric lens fit for our 3 diopter with the rule cornea was calculated using the popular method described earlier. The fit is on Kf, with 2 diopters of base curve toricity, therefore undercorrecting corneal toricity by 1 diopter for adequate rocking room. The overall diameter is 9.0. (25 sec)

LENS FIT: On Kf/2.0 D Toricity/9.0 mm

This is the empirical optimal lens on our patient's right eye. The Fl pattern is aligned and shows good edge feathering, though minimal temporally where the patient's cornea is flatter. This, and temporal centration of the lens as predicted by topography analysis cannot be improved. Movement is good with blinking.

VARYING BASE CURVE

(10 sec)

BASE CURVE ON Kf
(Optimal fit on Kf)

<table>
<thead>
<tr>
<th>Steeper than Kf</th>
<th>Flatter than Kf</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The first lens series will involve varying the Kf base curve. Lenses will be shown which are steeper than optimal by a quarter diopter, a half diopter, 3 quarters diopter, and 1 diopter, and flatter than optimal by a quarter diopter, a half diopter, and 1 diopter. (30 sec)

REMEMBER
Toricity kept constant at 2.0 D
Diameter kept constant at 9.0 mm
Remember that in this series toricity will be kept constant at 2 diopters, and diameter will be kept constant at 9.0. The only parameter changing is base curve. (20 sec)

(\textit{cl shot})

EMPIRICAL OPTIMAL: On Kf

The empirical optimal lens fit on Kf is shown again.

(\textit{cl shot})

0.25 D Steep

The base curve is steeper by a quarter diopter. The Fl pattern is similar to the empirical optimal fit. Centration and movement are good. This is an acceptable fit.

(\textit{cl shot})

0.50 D Steep

The base curve is steeper by a half diopter. There is a shadow from 7 to 10 o’clock due to placement of the light source. Fl pattern, centration, and movement are good and are similar to the empirical optimal fit. This is an acceptable fit.

(\textit{cl shot})

0.75 D Steep

The base curve is steeper by 3 quarters diopter. Fl pattern shows moderate pooling just temporal of the pupil. Lens movement shows less snap back than optimal. This fit is borderline acceptable.

(\textit{cl shot})

1.0 D Steep

The base curve is steeper by 1 diopter. Fl pattern shows central pooling, and there is a band of mid peripheral bearing, which blocks adequate tear flow. This is an unacceptable fit.

(\textit{cl shot})

EMPIRICAL OPTIMAL: On Kf

The empirical optimal lens fit on Kf is shown for comparison.
The base curve is flatter by a quarter diopter. Fl pattern shows apical bearing best visible just after blinking. Edge lift is inadequate causing seal off which decreases tear flow. This is an unacceptable fit.

The base curve is flatter by a half diopter. Fit is significantly affected as seen by lens drop and inferior centration. Although there is excessive Fl here, central bearing is evident. This is an unacceptable fit.

The base curve is flatter by 1 diopter. The lens has dropped and is sitting inferiorly. An air pocket has formed. This behavior is unacceptable.

In this series overall diameter will be varied to show the effect on fit. Lenses smaller than optimal will be 8.7 mm and 8.4 mm. Lenses larger than optimal will be 9.3 mm, 9.6 mm, and 9.9 mm. Reducing diameter effectively creates a flatter fit, whereas increasing diameter effectively creates a steeper fit. (35 sec)

REMEMBER
Base Curve kept constant on Kf
Toricity kept constant at 2.0 D

Remember that in this series base curve will be kept constant on Kf, and toricity will be kept constant at 2 diopters. The only parameter changing is overall diameter. (20 sec)

(cl shot)
EMPIRICAL OPTIMAL: 9.0 mm OAD

The empirical optimal lens with an overall diameter of 9.0 is shown for comparison.

(cl shot)
8.7 mm OAD

The diameter is decreased to 8.7 mm. The patient subjectively reported increased lens awareness because the superior lens edge is at the lid margin. The lens occasionally drops inferiorly, and air pockets form, indicating an unstable fit. This behavior is unacceptable.

(cl shot)
8.4 mm OAD

The diameter is decreased to 8.4 mm. Centration is poor, movement is unstable. Fl pattern shows central bearing indicative of a flatter fit. 9 o'clock staining is evident. This fit is unacceptable.

(cl shot)
9.3 mm OAD

The diameter is increased to 9.3 mm. Fl pattern is good, and is similar to the empirical optimal fit. Movement is somewhat sluggish, but this fit is acceptable.

(cl shot)
9.6 mm OAD

The diameter is increased to 9.6 mm. Fl pattern shows central pooling with slight mid peripheral bearing, hinting at the classic double D pattern at 2 and 8 o'clock. Tear flow over the lens is not smooth. Lens drops inferiorly. This lens is too large.
9.9 mm OAD

The diameter is increased to 9.9 mm. This lens is excessively large. Fl pattern is difficult to interpret. Edge lift is minimal. Centration is inferior. Tear flow over the lens is not smooth. This is unacceptable.

VARYING LENS TORICITY
(Difference Between Two Lens Base Curves)

(10 sec)

<table>
<thead>
<tr>
<th>TORICITY</th>
<th>(Optimal 2.0 D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less</td>
<td>Greater</td>
</tr>
<tr>
<td>1.75</td>
<td>2.50</td>
</tr>
<tr>
<td>3.00</td>
<td></td>
</tr>
</tbody>
</table>

(Cornea has 3.0 D toricity)

In this series toricity, which is the difference between the 2 base curves of the lens, will be varied. A lens of less than the optimal 2 diopter toricity will be 1.75 diopters. Lenses of greater than optimal toricity will be 2.5 diopters and 3 diopters, or corneal alignment. (30 sec)

REMEMBER
Base Curve kept constant on Kf
Diameter kept constant at 9.0 mm

Remember that in this series 1 base curve will be kept constant on Kf, and diameter will be kept constant at 9.0 mm. The only parameter changing will be toricity. (20 sec)

(ocl shot)
EMPIRICAL OPTIMAL: Toricity 2.0 D

The empirical optimal lens with a lens toricity of 2 diopters is shown for comparison.
The toricity is reduced to a 1.75 dioptric difference between base curves. Poor wetting is evident. Lens toricity under correction results in a with the rule dumbbell Fl pattern. This also allows torsional rotation of the lens with blinking. Lens rotation can be devastating to clarity of vision in RGP’s with ground in refractive cylinder correction. This is unacceptable.

\[(cl\ shot)\]
Toricity 2.50 D

The lens toricity is increased to a 2.5 dioptric difference between base curves. This means the cornea’s toricity is under corrected by a half diopter for adequate rocking room. The minimal Fl does not show significant pooling or bearing. Centration and movement are good. This is an acceptable fit.

\[(cl\ shot)\]
Toricity 3.0 D

The toricity is increased to corneal alignment in both meridians on our 3 diopter cornea. This means there is no rocking room which is necessary for good tear exchange. Fl pattern show 360 degrees mid peripheral seal off which further decreases tear flow. Poor wetting is evident. Based on Fl pattern, this fit is unacceptable.

\[(cl\ shot)\]
EMPIRICAL OPTIMAL

We end this video with another view of our empirical optimal lens. Diagnostic fitting has shown that there is often a range of lenses which provide a good fit on a given cornea. Empirical calculations merely provide a reference point from which to start. The clinician must develop the ability to recognize features which indicate inadequate fit, such as poor Fl pattern and decenration. By improving fitting techniques, the closely interconnected relationship of good fit, good comfort, and good vision may be maximized. We hope this video has provided clear examples in recognizing optimal fits of bitoric RGP’s. (1 min) (fade in music)

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